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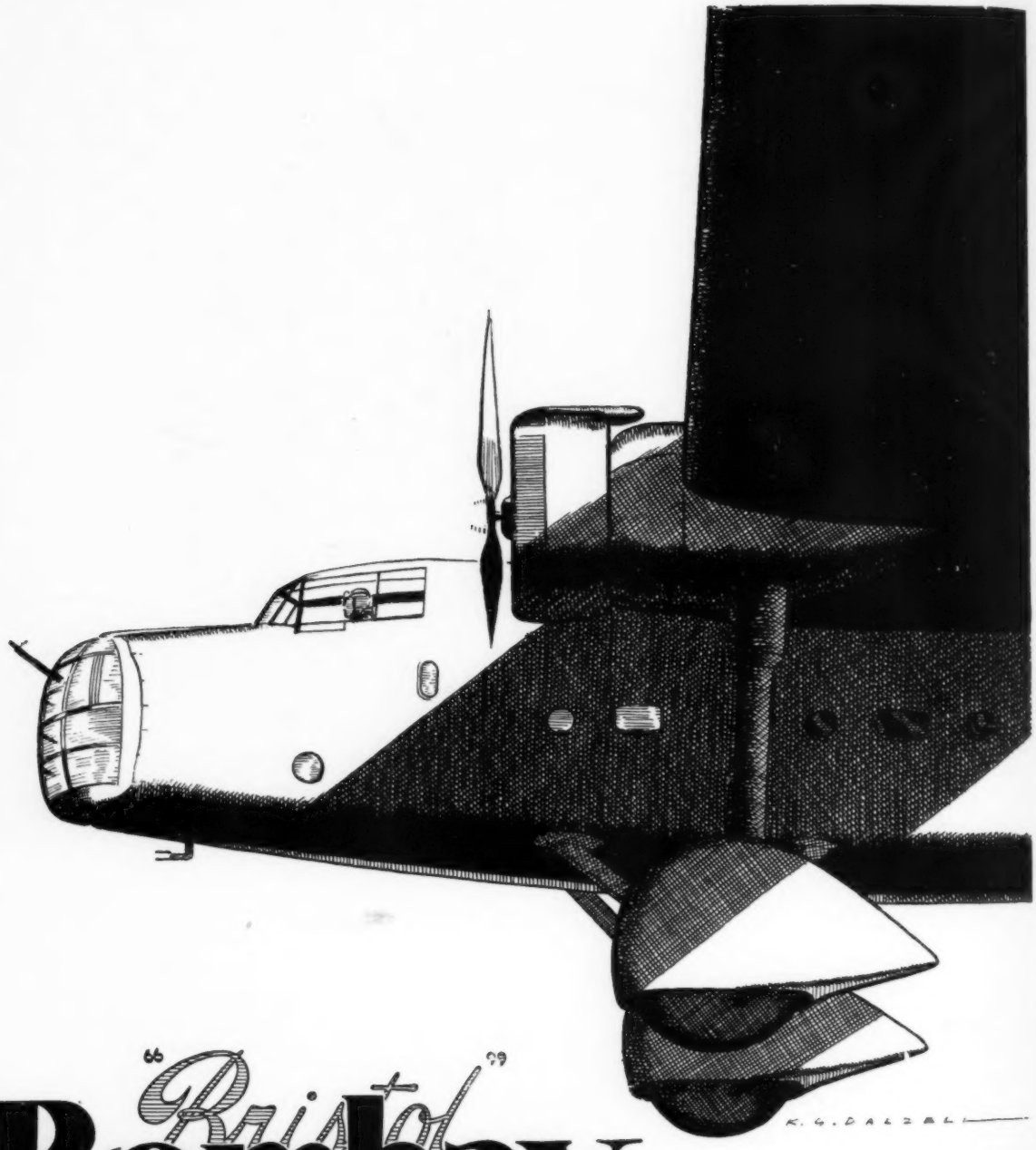

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FLIGHT

The AIRCRAFT ENGINEER AND AIRSHIPS

FIRST AERONAUTICAL WEEKLY IN THE WORLD : FOUNDED 1909

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The Outlook

Shadow Production

THE other day a cynic remarked to us that the so-called "shadow factories" are well named, as the only things they have produced are shadows. Like other epigrams, that remark overstates the case considerably, but there is no denying the fact that so far the shadow factories have, generally speaking, failed to equal in production the remarkable speed with which they were built and equipped.

Three weeks ago we said: "The expansion and re-equipment of the R.A.F. is the most vital preoccupation of the British aircraft industry. One may, perhaps, say that it is going on as well as could be expected, although the fact that Germany is believed to have produced 7,000 aero engines in 1937 and to be producing aircraft of all types at the rate of 400 per month gives no cause for complacency."

In some quarters that remark has been taken to mean that *Flight* is satisfied with the present rate of production. That is not so, as is proved in any case by the numerous occasions on which we have referred to the causes of delay. The expression was meant to indicate that the re-equipment of the R.A.F. was going on as well as could be expected by anyone who had taken the trouble to study the problems and face up to the difficulties. When the shadow factory scheme was announced *Flight* accepted it as a logical step, but did not under-rate the difficulties; we did not expect that all would be plain sailing, and that as soon as the factories were built and equipped a rapid and uninterrupted flow of aircraft and aero engines would follow. No one in close touch with realities could have been so ingenuously optimistic.

If we had lived in an ideal world, the thing to do would have been to let the "professional industry" produce the more refined, and therefore more difficult types, of engines and aircraft, leaving it to the shadow industry to make the less refined and more easily made types. But if we had lived in an ideal world there would have been peace on earth and good will among men, and there would have been no panic expansion. The whole trouble is that for many years Great Britain *thought* she lived in such a world, and she let her Air Force remain at a ridiculously and dangerously low level.

Successive Governments were to blame for living in this fool's paradise, and when the great awakening came Messrs. (the prefix is descriptive) Ramsay MacDonald, Stanley Baldwin and Anthony Eden, ably assisted by Lord Londonderry, had kept the aircraft industry on starvation diet for so long that no sane person could expect it to be in a position to expand its production at a moment's notice. No trainer would ask an athlete who had been out of training for years suddenly to enter a contest and expect him to do well in it against men in full training. Yet that is virtually what the Cabinet asked the aircraft industry to do when it—very belatedly—decided that Great Britain would have to re-arm.

What increased the difficulty of the problems was the fact that just about the same time the aircraft industry was changing over from forms of construction with which it was familiar to the so-called stressed-skin type. The industry struggled manfully with its problems; but can one wonder that it was more concerned with finding out how to build aircraft in the new way than with the question of whether or not this type of construction lent itself to mass-production?

Against that, it may be argued that stressed-skin construction was not new; that it had been used for a considerable time in America, and to a smaller extent in Germany. The answer to that is that while the British aircraft industry was kept struggling along in a hand-to-mouth existence by the Government, it could not afford to experiment—certainly not to the extent of making such drastic changes in structural methods.

Facing Facts

OUR excuse for possibly wearying many *Flight* readers with ancient history which must be well known is that it seems necessary to have the background correct if the picture of the present situation is to be true to life and to convey the proper perspective.

Having examined how the present position has come about, one is better able to appreciate the folly of trying to lay the blame on any one person, or set of persons, in the Air Ministry or outside it. The solution, unfortunately, is not as simple as that. Taking the charitable view, one may say that there have been, and are, short-

G-ADSR ! Last Monday morning the huge Armstrong Whitworth Ensign, first of the new 42-seaters for Imperial Airways, made her first flight, Flt. Lt. C. K. Turner-Hughes and F/O. Eric Greenwood taking her off from the A.S.T. Aerodrome, at Hamble, for an uneventful and satisfactory 15-minute flight. The machine, which is of 123ft. span, has four Armstrong Siddeley 800 h.p. 14-cylinder Tiger IXs.

comings both in the Air Ministry and in the industry. Both have, to a large extent, been the victims of circumstances, and there is little use in now pointing the finger of scorn. The thing to do is to attempt to locate the more serious causes of delay and, having brought them to light, try to find the remedy.

A Trouble Shared

TO understand the situation it is necessary to distinguish clearly between the things over which the aircraft designer has control and those over which he has none. In the former category is the airframe, and in the latter the equipment and engine. Whatever form of construction he adopts, he has several alternative ways in which he can attack his problems, but which ever he chooses, there is relatively little he can do to affect the final result. His military load and the range required are fixed by the Air Ministry, and little scope is left for really important improvements in structure weight. Every ounce counts, and to achieve the utmost efficiency the designer may well be driven to the adoption of some refinement which makes the construction more difficult from a production point of view.

The engine question is settled for the designer, within limits, by the fact that he has to use one of the three or four possibles available. Often the choice is even narrower than that, and the aircraft designer may be working to a specification in which the type of engine is already decided by the Air Ministry.

In the matter of equipment, the aircraft designer is entirely in the hands of the Air Ministry, and so numerous have become the various "services" in a modern military aircraft that, as *Flight* pointed out many months ago, the primary structure may almost be regarded as being of secondary importance. What runs away with most of the time is the installation of services and equipment.

That a military aircraft is of little use if it cannot carry the equipment necessary to its proper military functions may be granted. But it is in the interpretation of the word "necessary" that the multiplication from which we are at present suffering has arisen. One doubts whether the average pilot will find time, under actual war conditions, to make use of more than a small portion of the "gadgetry" with which the modern military aeroplane is provided. Still more does one doubt the feasibility of maintenance and servicing of all this paraphernalia in the field.

The trouble seems to be that equipment is necessarily under the control of specialists, and that each of these specialists is concerned with his particular equipment only. There does not appear to be at the Ministry any one official with an over-riding authority to say which particular equipment shall take precedence.

Multiplicity

ANOTHER cause of delay and trouble is the lack of standardisation. As long ago as December 12, 1935, *Flight* called attention to the situation. During the two years that have passed there has been no marked improvement, as will be gathered from the fact that of hydraulic pumps, to take but one concrete example, there are something like 16 types in use! Although hydraulic pumps are used for duties as varied as flap and undercarriage operation, interrupter gear and gun-turret control, that scarcely seems an adequate reason for not having reduced the number of patterns. They all run at different speeds, and the unfortunate aero engine designer is faced with a serious problem. The Bristol Company—in sheer desperation, one may imagine—has adopted the ingenious dodge of removing all but the essentially engine-related accessories from the back of the crankcase and has introduced a separate gear box for the drive of all the multitudinous and non-standardised accessories.

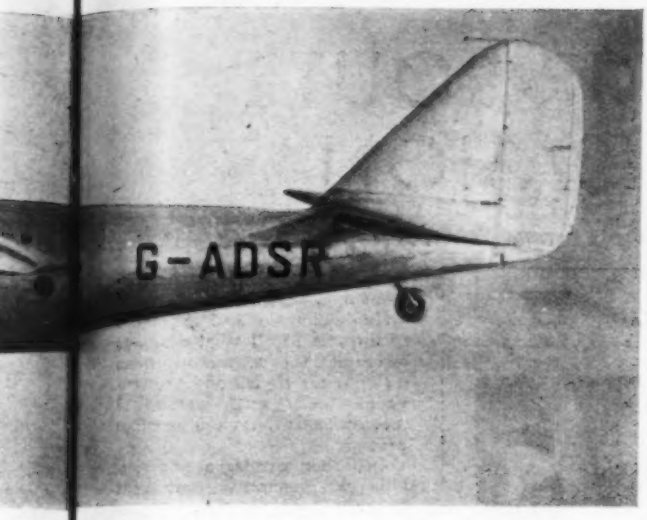
We have previously pointed out that the numerous materials specifications are another source of difficulty and delay. Some years ago an American aircraft manufacturer succeeded in reducing his materials specifications to *one;* it covered bar, tube and sheet. True, his machine was a small civil job, and we do not suggest that quite that degree of simplification could be achieved in materials for high-performance military aircraft; but that the present number of materials specifications is necessary we refuse to believe.

The Snags

TURNING more specifically to the Shadow Scheme, the position can be summed up by recalling that neither the engine nor the aircraft chosen for the shadow factories was specifically designed for mass production. That may be regrettable, but it was unavoidable. Remember that the establishment of the scheme coincided with a transition period in aircraft construction, and that if types in existence at the time had been selected they would have been out of date before they were built in quantities.

On the engine side it would have been a matter of designing an engine specifically for mass production, a process which would have taken years. And, in any case, not every part of an aero engine can be simplified for quantity production. Such things as cylinder heads *can* be die-cast instead of having to be machined all over, but the impeller of a supercharger, for example, *must* be dead accurate, running as it does at 20-odd thousand revolutions per minute.

It almost appears that the only way out of the impasse is to start yet another shadow scheme for production in



large quantities of simplified engines and aircraft, built as "second bests" to take the place of the first-line material inevitably lost during the early stages of a war. In the design of these the best production brains of the country ought to be consulted.

Plight of the Aerodrome Owners

THE keynote of the conference of the Aerodrome Owners' Association, held last week, was a general feeling of soreness that in the past the Government had urged municipalities to establish aerodromes, and now disclaimed any responsibility for the losses which they mostly are suffering. As one delegate put it, the municipalities had been bitten, and for the future they would be shy. Particular sympathy may be felt for a case like that of Darlington, with fewer than 100,000 inhabitants, which had acquired a large tract of land and whose delegates came to the conference asking pathetically whether there would be any chance of profit to their ratepayers if they were to develop it as an aerodrome. A claim was made that the Government should give each aerodrome £1,000 per annum; but as the Maybury report had refused to recommend financial help for aerodromes, and as the Government has accepted that report, the chances of getting that request granted seem very poor.

One delegate proclaimed boldly that, given traffic, they could make their aerodrome pay; and Mr. Ashley Hall carried the sentiment of the conference with him when he said that, if he had to choose, he would prefer help to be given to the operators rather than to the aerodrome owners. We might add that such a subsidy would at least give our manufacturers the necessary chance of producing the types of civil machines with which the overseas markets could be defended.

To be frank, it certainly seems that the precipitancy with which some Government servants and some private individuals once urged the municipalities to rush into the business of aerodrome-owning is largely responsible for the losses which the owners have since suffered. The Government may also be criticised for having delayed so long to give any guidance as to which inland airlines seemed most likely to be useful; and, now that the Maybury report has given some guidance of that nature, for delay in translating that report into action.

On Trial

THE internal airlines recommended in the Maybury report may be called, in official phraseology, test works. They ought to show whether, in favourable circumstances, airlines in this country can be made to pay, and, if not, whether they deserve public help as works of public benefit, and to what extent. Taxpayers, no less than ratepayers, will object to spending too much money on civil flying unless that flying is a means to an end and not an end in itself. Of course, civil flying may strengthen our defence reserves, but the Aerodrome Owners' Association was emphatic in its desire to leave that plea out of the reckoning.

Lord Londonderry, the President of the Association, made some very pertinent remarks, though mostly they applied to operators rather than to aerodrome owners. He said that if inland airlines flew only by day, they would "flounder." He instanced the Belfast business man who travels to London by night by steamer and train and would not fly by day because it wasted business time. The air service must also go by night. Presumably the ex-Air Minister had in mind a service which would leave Belfast after office hours in the evening and would get to London in time for the passenger to sleep comfortably in an hotel that night. That would seem to imply a through service, not stopping more than a minimum number of times on the way, and so benefiting very few aerodromes. It was that sort of service which Mr. Ashley Hall also advocated as an improvement on the Maybury scheme.

It would seem from that discussion that there is but a limited future for inland airlines considered by themselves. But again Mr. Ashley Hall talked good sense when he said that the main lines must be those overseas, and that inland lines must work in connection with them.

Exit the R.A.F. Display

SPECTATORS who, like many of the staff of *Flight*, have witnessed all the eighteen R.A.F. Displays at Hendon, may have become a little *blasé* and inclined to imagine that the later displays were less attractive than were some of the earlier ones. That view was probably not shared by the general public, which every year rolled up at Hendon in ever-increasing numbers and with no signs of flagging enthusiasm. Yet everyone (with the possible exception of the local residents) will join in the regret that such pleasures will not be enjoyed again.

The reasons given by the Air Council for abandoning the Display are valid enough, and must be accepted, though with regret. Modern fast aeroplanes take up too much sky-room to make a realistic spectacle of Air Force work within the limits of any aerodrome.

Instead of merely lamenting the past, let us see if any constructive suggestions for the future may be made.

Empire Air Day has grown in importance far beyond what even its originators, the Air League of the British Empire, can have expected, and no doubt it will grow still further. It appeals to a wider public than was possible for the Hendon Display, and we may expect that in time the Air Ministry will accept full responsibility for organising the day. There remains also the S.B.A.C. Display, which used to be held at Hendon on the Monday following the R.A.F. Display, but has been moved to Hatfield in recent years. The reason given for the move was the trouble of clearing up Hendon on the Sunday. That reason will no longer apply, and, if the Air Council agrees, this valuable exhibition might return to Hendon and be expanded in scope. Hendon is certainly the most convenient aerodrome near London for a public gathering.

It is understandable that the S.B.A.C. should wish to keep this display private for one day, so that prospective customers, foreign and native, should be able to view the static exhibition and the flying display without being embarrassed by a crowd. But there is now a large section of the public which would like to be admitted to Hendon to enjoy the sight of our latest prototypes as well as the engines and accessories. While the R.A.F. Display flourished in all its glory no other aeronautical show could hope to attract much public attention, but for the future a public day or two at the S.B.A.C. Display at Hendon would probably prove very popular as well as wholesomely instructive.

DIARY OF FORTHCOMING EVENTS—Page 89.

Airports Conference Papers

INTERNAL AIR-ROUTE RATIONALISATION

Some Detailed Suggestions for Putting Britain's Home Air Routes on a New Basis

By R. ASHLEY HALL

THE author of this Paper, read at the Conference last Thursday, knows his subject from the viewpoint of an airport administrator, an official of the Aerodrome Owners' Association, a flying club official, and a pilot.

In presenting his Paper to the Conference, Councillor Ashley Hall submitted the following resolution:

"The A.O.A. request that H.M. Government shall reconsider the following recommendations in the Maybury Committee Report:—Paragraph 124 dealing with financial assistance to aircraft operators. Paragraph 100 dealing with financial assistance to aerodromes, and paragraph 128, and the suggestions as to a limitation of the main air routes under the "function plan."

In the Paper he proceeds to detail a bold, comprehensive scheme for the reorganisation of Britain's internal airlines—a scheme which would call for, and justify, a Government subsidy for both aircraft and aerodrome operators.

The Paper (originally entitled "Organisation of Air Transport in Great Britain") has been very slightly abbreviated for publication here, and the appendix has been summarised in the form of a map

WHEN aviation was first considered as a possible method of serious civil transport, it was at once obvious that there would be a problem involving two main factors—the operation of the aircraft themselves and the provision of the ground organisation.

There was a danger of a vicious circle being set up, in that air transport would not develop, through lack of aerodrome facilities; and that aerodromes would not be provided owing to lack of air transport demand

It was obvious that whereas an aerodrome could exist, even if unused, an aeroplane could not fly unless it had aerodromes from which to operate. Consequently, in spite of the desirability of aerodromes and aircraft operation developing side by side, it was necessary for the aerodrome to be first, and always slightly ahead of the aircraft operator.

A Campaign

And so the authorities, the Directorate of Civil Aviation at the Air Ministry, initiated a campaign for aerodromes, aerodromes everywhere, more and more aerodromes. The campaign reached its climax in the mass meeting held at the Mansion House in London in 1929, addressed by H.R.H. the Prince of Wales.

By this time considerable progress had been made. A number of municipal and private aerodromes had been established.

In the years immediately following there were considerable signs of life in the sphere of aircraft operation. Numerous companies were formed and a number of air services were inaugurated.

Their history has, on the whole, been a sad one. Many were under-capitalised, the personnel were lacking in experience, the aircraft used were unsuitable, and the complete lack of navigational aids made regularity or punctuality impossible. The travelling public were not "ready," and in the majority of cases the methods of airline operation did little to create confidence in this new method of travel. It was a period of the survival of the fittest.

These years were useful, however, in providing experience and in teaching many lessons. Among them was the fact that organisation and complete navigational aid were necessary if air transport within the United Kingdom was to be enabled to operate in a manner that would be useful to the public and would earn their confidence. Aerodromes had to be bigger and better equipped; lighting equipment was necessary for night and emergency landings; ground-to-air communication with wireless, and ground control by specially trained personnel capable of giving guidance and assistance to aircraft in all weathers, was essential; the control of traffic on busy air routes and the provision of greatly enhanced meteorological services was also necessary.

In other words, a considerable and general improvement in ground organisation was an essential. The improvements necessary were designated in detail in the Maybury Committee Report published in January, 1937.

New Stage

The recommendations made are in the process of being introduced, and one can say that in 1938 *the aerodrome ground organisation, wireless, etc., position within the United Kingdom will be on a basis sufficiently satisfactory and efficient to support the operation of a serious system of internal airlines.*

So now we must look forward to further development, and the form that this should take is also covered in the Maybury Report. But, unfortunately, there seems room for considerable criticisms as to the efficacy of their suggestions Their recommendations as to the air routes and their operation are rather like the curate's egg; so rather than criticise and suggest revisions it would be better to propound what, in my opinion, should be certain guiding principles from which, perhaps, a new egg can be hatched.

The principles which should be borne in mind when considering air transport within the United Kingdom are:—

(a) Before anything useful can be accomplished it must gain the confidence of the public To do this it must be: (i) regular and punctual, (ii) free from accidents, (iii) comfortable. Aids to these ends are to be provided by the ground organisation as recommended by the Maybury Report. As regards aircaft, the obvious requirements are specially trained personnel; up-to-date multi-engined machines with a crew of never fewer than two and equipped with efficient heating and ventilation and always with a lavatory; and it is agreed that a steward or stewardess serving refreshments is a considerable moral comfort.

(b) Airlines must create *new* movement and not attempt to compete with other methods of transport. For example, the movement to-day is comparatively small from the south-west, through Nottinghamshire, Leicestershire, Northamptonshire and to Norfolk, etc., because the existing means of travel are inconvenient. A convenient method of communication provided by air transport should create new movement.

There are many routes which, by running diagonally to the main railway lines, would offer greatly improved communications and so would create new movement.

By its speed, air travel should encourage journeys that time would not allow by any other means. It has speed only to sell. Therefore, it should concentrate on express services, not the "hopping" services being run to-day.

Glasgow to London should be non-stop at 200 m.p.h., not via Belfast and Liverpool. The "hopping" services should be subsidiary to the "express" non-stop services.

There are a number of routes where only air travel could enable a provincial resident to go to London for the day; by existing methods of transport a day, or even part of a day, in the capital necessitates the night as well.

Again, Bristol is 120 miles from London. The Bristol business man can spend the morning in his home office, travel to London by train at midday, be in his London office by 2.30 p.m., do an afternoon's work there, and still be at his home in Bristol for dinner. Air transport could provide the same convenience between towns 200, 300 or 400 miles apart.

(c) Internal airlines must connect the great ocean ports of England.

(d) Internal airlines must connect the airports of entry of overseas routes to England.

(e) The main termini and junction airports of England must be connected by feeder-line services to other important centres in their locality.

(f) A limited number of "main express air routes" within the United Kingdom should be established immediately. These will create the backbone of the skeleton from which other lines will develop as the public demand and confidence increases.

[Mr. Ashley Hall's suggested "backbone" is shown in the map on page 86.—ED.]

(g) All air routes, whether main routes, subsidiary routes or ferry services, should be licensed—the Air Ministry, however, reserving the right to designate which, in their opinion, are routes that serve a useful public service. Only such "useful" routes need be licensed. Licensed routes should be subject to strict traffic control.

The Ministry should lay down a standard of efficiency and equipment required for each approved route, and a licence to operate on this route being granted only to a company that can satisfy the Ministry accordingly. The standard can be raised from time to time as progress in equipment, etc., is made. This will assure the travelling public of "the best" and will avoid the odious suggestion of monopolies.

(h) It might, however, be worth considering the establishment of one "United Kingdom Airways" to operate what may be the "backbone" routes. The reason for this will be seen under the section dealing with subsidies.

"United Kingdom Airways" should be a company primarily interested in the progress and development of air transport, and not unduly influenced by its interests in any other method of transport.

If the only way to make air transport within the United Kingdom useful is for it to operate on the lines suggested above, at very high speeds, with reduced pay-loads on account of the necessity of carrying a multiple crew, conveniences for passengers, full navigational equipment, etc., it must be obvious that the overhead expenses of operation will be very high and uneconomical, particularly during this period of building-up goodwill and public confidence.

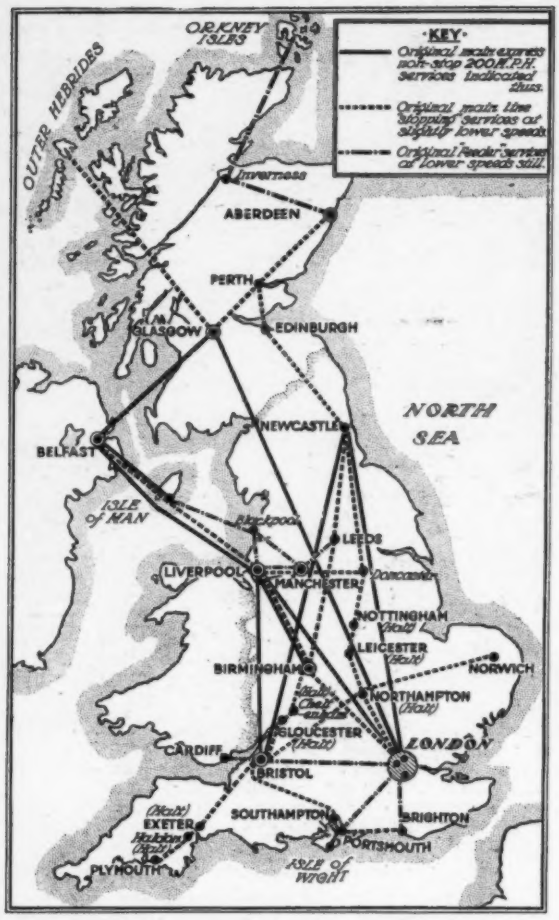
Subsidy Suggested

Consequently, it is unlikely that private enterprise will undertake it unless it has some assurance against financial loss. And the only assurance it can have is a guarantee of financial assistance by the State—in other words, that there should be a State subsidy for internal airlines.

I do not see how they can operate efficiently without one. I believe it better for the future interests of aviation that, unless the airlines can operate efficiently and with regularity and punctuality, they should not operate at all.

The form I suggest that the subsidy could take is, first of all, a flat rate sum per annum for an agreed number of years to a big company that undertakes the operation of the "main" air routes which will create the backbone; this would be "United Kingdom Airways" already referred to. Over and above that there would be a "piecework" payment on approved route mileage to each and every company in respect of the services it operated on approved "licensed" air routes.

The Air Ministry would, of course, only licence (and so subsidise) those routes which they felt to be in the public



The internal routes suggested by Mr. Ashley Hall. Certain points would also form junctions for services leaving the country, e.g.: Liverpool for N. Ireland; Newcastle for Scandinavia; Bristol for Eire; Southampton and/or Portsmouth for Isle of Wight, Channel Islands and Empire routes; Brighton for Continental North Coast; London for European services; Doncaster for Holland; Perth for Northern Scotland and Northern Islands. It will be noticed that certain places are "by request" halts.

interest. Payment of subsidy on these terms would ensure the Air Ministry of complete control and a high standard of efficiency.

Aerodrome owners should press for and support any endeavour to obtain a subsidy for air transport operators. As aerodrome owners we are glad of the arrangements that have been made for the provision and operation of wireless, control and meteorological services. But what is the use of having our nice aerodromes and ground equipment if they are not to be put to practical purposes? We want our aerodromes used. We want more air transport, so let us support anything that encourages more air transport.

Experience has proved that financial assistance is necessary for the development of other air routes, i.e., Imperial Airways and British Airways services, and it is considered that home airway routes also need assistance before any serious development can be expected.

As regards aerodrome finance, here, too, there are unanswerable claims for assistance. No aerodrome used for purely civil purposes is economically sound. If charges were imposed on civil aircraft operators in relation to the cost of the services provided, they would create an intolerable burden.

There are three parties interested in the provision of an aerodrome, and each should subscribe his share. The first is the user—the aircraft operator. He must pay in relation to the use he makes of any particular aerodrome. The second is the community resident in the vicinity who are enabled by the presence of an aerodrome to enjoy directly or indirectly the advantages offered by this new form of transport. The third is the State, to which every aerodrome is a useful reserve base in the event of a national emergency and the consequent necessity for a further hurried expansion of the Royal Air Force.

Subsidy Suggestions

The form that such a subsidy could usefully take would be a flat-rate payment per annum to public-use-licensed aerodromes only. The amount needed would not be a heavy burden on the taxpayer. A "token" payment of £1,000 a year to each "all-purpose public use" licensed aerodrome would, in my opinion, be a fair contribution from the State and an encouragement to aerodrome development.

Civil aerodromes already receiving revenue from military use—for example, those at which Auxiliary Squadrons or Reserve Schools are stationed—should not be entitled to a subsidy from the State.

In conclusion, we may set forth reasons why subsidies to civil aviation within the United Kingdom are essential.

Such civil aviation cannot be operated on the most efficent lines without financial aid.

A volume of civil air transport within the United Kingdom is desirable:—

(a) To foster interest generally in world-wide British air transport.

(b) To create an assured civil market for the British aircraft industry and to provide first-hand experience of air transport operation, and so assist in the production of aircraft that will sell abroad.

(c) To create and retain a reserve of aerodromes, aircraft, pilots, navigators, engineers, etc., for the Royal Air Force.

(d) If Great Britain is to build a great mercantile air service throughout the world Britons themselves must be in sympathy with air transport, become acclimatised to its everyday use and gain experience of it on their "home" lines.

THE R.Ae.S. RECEPTION

ONCE more the annual reception of the Royal Aeronautical Society can be written down a complete success. The films of unusual aircraft were much appreciated and the laughter indicated that our technicians are gifted with a keen sense of humour. The reception was held, as usual, in the Science Museum, South Kensington.

The guests were received by Mr. and Mrs. F. Handley Page, in the absence (in Australia) of the President of the Society, Mr. H. E. Wimperis.

During the evening Mr. Handley Page presented the society's medals and awards to the recipients. The Simms' gold medal was awarded to Dr. N. A. de Bruyne for his paper on "Plastic Materials"; the Taylor gold medal went to Mr. George Mead, of America, for his paper on "Power Plant Trends"; Dr. Gustav Lachmann was awarded the Wakefield gold medal for his paper "Aerodynamic and Structural Features of Tapered Wings."

The Edward Busk memorial prize was divided between Major B. C. Carter, of the R.A.E. (Paper: "Airscrew Blade Vibration"), and Mr. A. G. Pugsley, also of the R.A.E. ("Control Surface and Wing Stability Problems"), and the Pilcher memorial prize was also divided, the two student members being Mr. A. J. Hanson ("Critical Speeds of Monoplanes"), and Mr. C. O. Vernon ("Aircraft Performance Estimation").

The R.38 memorial prize was awarded to a student, Mr. A. A. Hall, B.A., for his paper on "Turbulence and Skin Friction Problems."

THE AIRPORTS CONFERENCE

Members of the Aerodrome Owners' Association Get Together : The Question of Financial Assistance : Points from the Discussions

SOMETHING like 140 delegates from all parts of the country, and from Belfast and Dublin, attended the fourth annual Conference of the Aerodrome Owners' Association last week. The majority of them appeared to be obsessed with the idea of obtaining some kind of financial assistance from the Air Ministry and this matter cropped up both at the dinner and at various other moments.

However, Sir Francis Shelmerdine, the Director-General of Civil Aviation, rather naturally failed to mention the matter in the course of his remarks when, on Wednesday of last week, he opened the Conference. He mentioned that membership of the Association had increased to 66 this month, and it was subsequently announced by the retiring chairman (Mr. J. W. Bateman) that the Manchester Municipality had become a member that very morning. The Association, said Sir Francis, had now accumulated a large store of information, and he mentioned that the quarterly meetings between it and the Department of Civil Aviation, the first of which had been held last October, were producing very good results.

During the day the Conference approved the appointment of six representatives to give evidence before the Cadnam Committee, and instructed those representatives to insist on the need for financial help for aerodrome owners. During 1936 and 1937 it appeared that the total losses on 28 aerodromes were £137,107. Standard fees for all aerodromes represented by the Association were approved, the secretary, Mr. Gillman, explaining that the need for separate aerodrome classification in this matter was no longer apparent. The charge schedule would take effect from March 1 and included a landing fee of 9d. for every 1,000 lb. of the permissible loaded weight of a machine.

A report of the banquet which was held in the evening appears on page 92d.

Thursday was a day of papers and discussions. The papers are given (either in full or in suitably amended forms according to their character) in other parts of this issue, and the more important points from the discussions are reviewed below.

"*Flight*" photograph

Conference in being : the officials on the platform are, left to right, Mr. H. R. Gillman (secretary of the S.B.A.C. and Aerodrome Owners' Association) ; Lt.-Col. Sir Francis Shelmerdine (Director-General of Civil Aviation) ; Mr. J. W. Bateman (retiring chairman, A.O.A.) ; Mr. C. M. Newton (new chairman) ; and Councillor R. Ashley Hall (vice-chairman.)

THE DISCUSSIONS

FOLLOWING Mr. Ashley Hall's paper, which supported the idea of the establishment under subsidy of really good high-speed air services, Lord Londonderry, the President of the Association, suggested that aerodrome owners should go in for a system of costing; such a system would carry weight with the Government, who would be able to see exactly where losses occurred and how a profit could be made. He urged the necessity for night flying, saying that when he was coming from the North of England to London it was more convenient for him to come by train, though it suited him well to fly from Belfast. Unfortunately, even this did not suit the ordinary Belfast business man, who preferred to travel by night in boat and train in order to lose no working time.

A number of delegates agreed with Mr. Ashley Hall that the primary need in Great Britain was to encourage the operation of air services and so increase the aerodrome revenue, though they insisted that, in the circumstances, the Government should help to bear their losses, which were, at the moment, inevitable. In the course of the discussion there was a tendency towards rivalry between the different towns, and this was deprecated by Mr. Ashley Hall and by other speakers.

Mr. H. Hopkins, of Darlington, asked Mr. Ashley Hall to consider the case of a small provincial town with less than 100,000 inhabitants. They at Darlington possessed a large piece of suitable land and they wanted to know what to do next. Was there any chance of profit to the ratepayers if they developed an aerodrome? To go back and say that it would be a national service would, he feared, cut no ice with them. Mr. Ashley Hall replied that though the main air services must necessarily go overseas, they must be connected with inland airlines, and that passengers from abroad would wish to fly on to their destinations.

A Bristol delegate said that the Government had urged the municipalities to set up airports, and since those municipalities which had done so had been bitten, others would think twice before following suit. The Government should bear the responsibility. He realised that this country was too small for air services and the chances of profit were small. Mr. Ashley Hall stated that though at first he had been active in urging municipalities to make aerodromes, he had at one stage written to the late Sir Sefton Brancker to say that he would do so no more unless the position was consolidated.

Aerodrome Management

Following Mr. M. H. Volk's paper on aerodrome management, there was some discussion on the liabilities involved when a mobile refuelling unit hits a machine and damages it. Quoting another point from the paper, a Singapore representative—not a delegate—explained that the "doming" of an airport advocated by the speaker must not, of course, be such as to interfere with taxying, taking-off or landing, and must not create blind spots or be so pronounced as to produce violent drainage effects.

There was some discussion, too, concerning the usefulness of a signalling system such as is in use in Germany, some considering the system dangerous and others efficient. Mr. Volk's reply was that the flagman's signal in the matter of take-off was permissive rather than obligatory, and that the responsibility for avoiding any kind of obstruction remained with the pilot. If the design of the machine did not allow the pilot to see behind him, then the Air Ministry ought not to have given the machine a C. of A

There were also some questions as to the future of those control officers who are already employed by airport authorities; they were asked in connection with the remarks made by Mr. Wilson in his paper on air traffic control concerning the Air Ministry training scheme.

Britannia Trophy for Clouston

THE Royal Aero Club announces that it has awarded the Britannia challenge trophy for the year 1937 to F/O A. E. Clouston for his record flights from London to Cape Town and back, and for his Damascus Race performance.

Airports Conference Papers

TRAFFIC CONTROL PLANS

How the Recommendations of the Maybury Committee Will be Carried Into Effect : Mr. A. H. Wilson's Paper on Air Traffic Control

Croydon's control tower. (*Flight* photograph.)

IN some ways Mr. Wilson's paper contained much the same subject-matter as that covered by the article, published in last week's special Airports Number of *Flight*, on the present trends and probable future development of air-traffic control. As an Air Ministry official, however, he was able to go into greater detail in the matter of the plans for the immediate future, and in this summary we shall endeavour to give prominence to those details while preventing, as far as possible, any unnecessary repetition.

The speaker, in his foreword, dealt briefly with the purposes served by direction-finding radio services and with the special part played by control officers. In a short historical survey he reminded his listeners that in 1920 the Air Ministry provided non-D/F radio stations at Croydon, Pulham, Lympne, Castle Bromwich, Manchester and Renfrew. This organisation was on more liberal lines than the circumstances warranted, and the last three stations disappeared for the time being. Croydon, Pulham and Lympne survived and were fitted with D/F facilities to assist the London-Continent air services. From 1925 onwards these three stations operated in conjunction to give pilots their positions, and in 1931 Manchester was again provided with a station. By 1933 it was evident that the existing stations were insufficient to serve inland as well as Continental traffic, and a five-years' plan was therefore authorised to provide a network of radio stations.

"Areas" and "Zones"

Meanwhile, the need for a ground-control staff and of a definite operational procedure in the Croydon area had been recognised. A Continental Airways area and a bad weather controlled zone were instituted. Mr. Wilson then described the systems used for the Continental area, and explained that it became necessary to have a similar, although not so elaborate, system of control wherever wireless facilities were set up. It was recognised also that this system should be under unified control. It was an essential feature of the "five-year" network that wherever a wireless station was installed the local aerodrome authority was to be called upon to provide control staff, but that the wireless station was to be provided by the Air Ministry on repayment by the local authority. It was, however, recognised that the cost of providing, maintaining and staffing wireless stations would put a heavy burden upon aerodrome owners, which, in the state of the operating industry, they would have small chance of recovering. The repayments were therefore fixed at a small percentage, usually ten, of the actual cost of running the stations, the balance borne by the Air Ministry. The aerodrome owners were, however, expected to co-operate by the provision of buildings and certain ancillary services.

As the precise course of new internal air routes could not be accurately predicted, the majority of the transmitting stations were mounted on trailers and receiving plant was, in most cases, housed in buildings of a temporary nature. A few permanent D/F stations were, however, visualised at aerodromes where their future need was obvious. The stations were sited so as to provide navigational aids to the network of internal services as a whole rather than to serve the needs of individual aerodromes and, in order to avoid wavelength congestion the number of stations had to be limited, necessary point-to-point communication being provided by land-lines. For local guidance, where traffic warranted this course, it was intended to provide a limited number of short-range D/F stations—since at that time a suitable type of radio beacon for homing had not been developed.

In 1933 the only internal radio stations were at Manchester and Renfrew, of which the former alone communicated with aircraft. In 1934 the hours of watch at Manchester were extended and Renfrew was equipped to communicate with aircraft by radio telegraphy. The first new station to be erected under the plan was at Heston, in order to relieve Croydon. Three mobile stations came into operation in 1934 at Hull, Portsmouth and Newtownards. A teleprinter service was put into operation between Manchester and Liverpool, and the Heston station was similarly connected with Croydon.

By the end of 1935 the number of internal civil stations was twelve, and at the same time the need for air traffic control was being recognised. The control at Heston was taken over by the Air Ministry. Consideration was given to a scheme whereby a number of communication areas, each equipped with a radio station, would be defined and aircraft whilst in these areas would be given advice and instruction, these areas to be linked by land-line. During 1936 radio facilities were extended along these lines and it was decided to expand the Communication Area system to cover the whole of the United Kingdom. There are now sixteen area stations and five short-range stations, in addition to the Borough Hill broadcast station. All but two of these (Jersey and Sollas) have been provided by the Air Ministry.

The work of transforming the existing network into the comprehensive organisation recommended by the Maybury Committee lay mainly in augmenting and improving the equipment, increasing the number of land-lines and putting on a permanent basis a number of stations at present regarded as mobile, and providing night-flying radio facilities. In addition, it would be necessary to provide additional short-range stations at certain aerodromes.

Control Problems

As regards control, the position was not so satisfactory. It had been found difficult by aerodrome authorities to provide a really suitable standard of personnel for this work, and the control organisation as it existed throughout the country could not be said to be adequate. Apart from this, the present wireless and control organisation differed from that recommended by the Maybury Committee in that aerodrome authorities had, in the past, contributed to the cost of maintenance and staffing of the wireless stations, had provided accommodation and certain other services at their own expense and had at their own charge provided the control staff. There were thus two aspects of the recommendations to be considered, the one being the relief of aerodrome owners from the financial liabilities they had hitherto borne, and the other being the amplification of the existing network and provision of competent traffic control staff.

Steps were already being taken to deal with the first of these aspects. After April 1, 1937, the contributions hitherto payable by aerodrome authorities were abolished and an undertaking had been given that from the same date the Air Ministry would accept liability for any expenditure involved in the continuance of services already approved. Forms of enquiry had been issued to aerodrome authorities asking for particulars of staff employed by aerodrome authorities on what

were, under the Maybury recommendations, to be regarded as Air Ministry services. In most cases traffic conditions did not warrant full-time employment, and the personnel performed other work for which the Air Ministry would not become responsible, and it was necessary to apportion the costs of staff between the Ministry and the aerodrome owners. When the various measures had been completed there would be in existence radio facilities and an air traffic control organisation in connection with which no expense should fall on aerodrome proprietors.

The need for taking these interim measures arose from two considerations. The difficulty of finding suitable personnel could only be met by the recruitment of personnel and an Air Ministry training school had accordingly been set up. There was, however, a limit to the rate at which personnel could be trained.

So far, owing to lack of suitable instructors, it had only been found possible to conduct one course at a time, and the limited number of Air Ministry control stations restricted the number of pupils who could be given practical training. The second consideration concerned the need to provide "a comprehensive air traffic control organisation adequate to secure the safety and regularity of air communications." This involved the detailed study of a number of very difficult problems—technical, operational and administrative—and the carrying out of the ultimate plan by stages and at a rate governed by many factors.

Search for a Basis

One of the major difficulties was that of forecasting the ultimate needs of internal air services. The majority of the services were still experimental and seasonal, and there were no data available. Until, however, ground facilities were evolved, there was little hope of any internal service achieving real permanence. The solution would appear to lie in the provision of an efficient and economical elastic control basis. While it was desirable that facilities should be permanent in character, it was not essential that they should be permanent in location. The capital sum involved in moving equipment would only be a fraction of the annual expenditure, except in the case of long-range Adcock direction-finding apparatus, and it is therefore desirable that such apparatus should be provided at stations which were quite permanent. The needs of internal services could best be met by providing facilities to serve areas and not specific routes. The majority of area stations could be considered permanent.

There remained, however, the problem of providing radio approach facilities at aerodromes. The character of these facilities would be dependent on the density of traffic and would fall into three different categories: 1, A short-range station, a V.H.F. approach beacon and land-lines linking the aerodrome to the area station; 2, a V.H.F. approach beacon with a land-line link to the area control; and 3, a land-line linking the aerodrome to the area control. Until services were stabilised, it would not be practicable to regard such facilities as permanent, and a variation in traffic density between aerodromes would involve the transfer of equipment.

The typical area radio station would consist of one or more medium-range transmitting and receiving channels. At exceptionally busy area stations, a short-range radio station would also be provided to relieve the congestion by handling local traffic during peak periods or in conditions of bad visibility.

The area equipment would generally have to be permanently housed and would normally be equipped with Adcock D/F apparatus. Each main area station would be linked to its adjacent area by teleprinter and telephone lines, as well as to subsidiary aerodromes within its area. The current procedure was for the aircraft to receive route guidance from the area station until it reached the vicinity of the aerodrome, where it would then use the local approach facilities. Owing to the shortage of frequencies two short-range radio stations could not be sited within approximately 60 miles of each other. The range of interference of an ultra-short wave beacon was thought to be about 25 miles, and it was not expected, even when certain apparatus at present under test was perfected, that it would be possible to repeat more than six wavelengths within that radius. At present only three wavelengths could be so repeated.

The Immediate Plans

As at present visualised, the layout of facilities comprised thirteen area stations and four collaborating stations. Of these area stations, ten exist, two represent probable transfers of existing stations and one would be an entirely new station. About twelve short-range stations were contemplated with an additional four at busy area stations. An appreciable number of V.H.F. beacons were proposed for aerodromes where conditions warranted them. Except at one of the collaborating stations (Pulham) it was contemplated that Air Ministry control staff would eventually be provided at all radio stations. A considerable number of control officers would be required, and it will be appreciated that their training was a formidable task, since until recently there were only eighteen control officers in the service of the Air Ministry. There would also be a considerable expansion of communications staff, and their training would not be without its problems.

The rate at which the organisation could be developed was dependent on a number of factors. Two of these were of outstanding importance. They were the difficulty of training and accommodating the expanded organisation. It would probably be found that, at any rate at area stations, rather more generous accommodation would be wanted for Air Ministry control staff than had hitherto sufficed for the aerodrome owners' own control personnel. It was hoped that aerodrome proprietors would be prepared to provide the necessary accommodation on rental terms. Other things being equal, control staff would, however, be posted first to those stations which had the greatest density of air traffic.

Meteorological Reorganisation

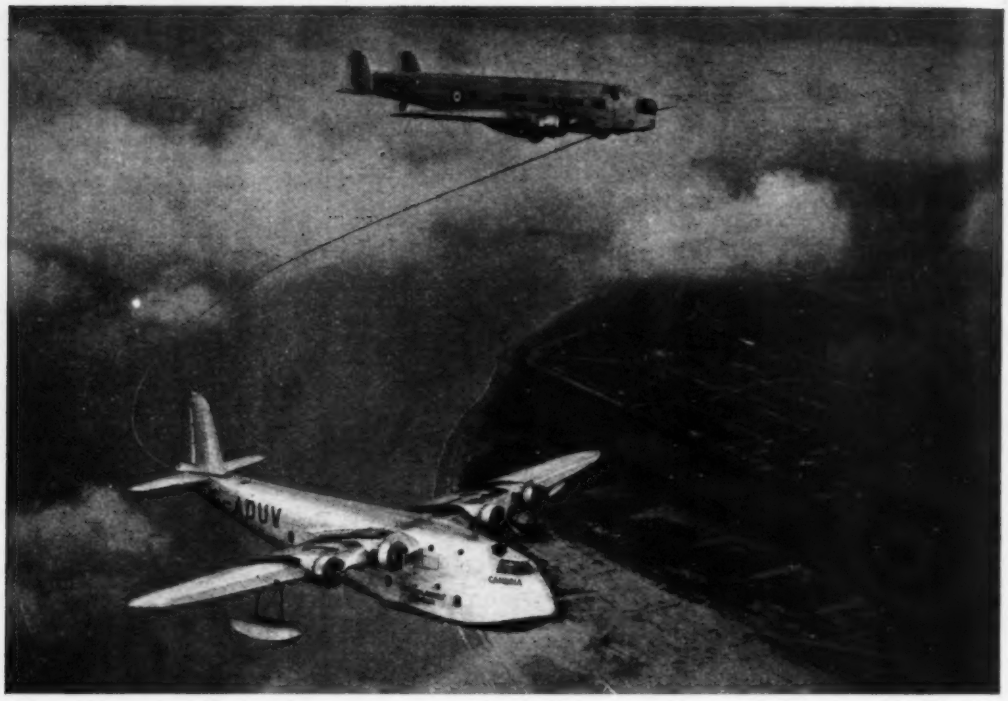
Meteorological facilities would be equally reorganised. At present, forecasting facilities existed at Croydon, Manchester and Bristol, while a number of other civil aerodromes were linked by land-lines to stations at adjacent R.A.F. aerodromes. The facilities needed to implement the recommendations of the Maybury Report were at present being considered by the Meteorological Office. Present indications were, however, that operational requirements would be nine forecast stations within the United Kingdom capable of supplying reports of existing weather and forecasts of anticipated weather along any route within a radius of 300 miles, and fifteen subsidiary stations on other civil aerodromes where reports of existing weather would be available and where forecasts of anticipated weather would be obtainable from the control stations. In addition the reports from a large number of R.A.F. aerodromes would be available for civil aviation if required. In general the existing and proposed meteorological stations would be interconnected by a landline system separate from that of the control and signals organisation.

Forthcoming Events

January 28. Northamptonshire Aero Club: Annual Ball at Salon de Danse, Northampton.
February 3. R.Ae.S. Lecture*: "Recent Research on Aerodynamic Characteristics," by Mr. E. F. Relf.
February 8. R.Ae.S. Isle of Wight Branch Lecture: "Tank Testing of Flying-boat Hulls," by Mr. L. P. Coombes.
February 9. York and Leeming Flying Club: Annual dance, Grand Hotel, Harrogate.
February 10. R.Ae.S. Portsmouth Branch Lecture: "Cowling and Cooling of Radial Engines," by Dr. G. P. Douglas.
February 11. D. H. Aeronautical Technical School: Annual Dance, Hyde Park Hotel 9 p.m.
February 17. R.Ae.S. Coventry Branch Lecture: "Aircraft Motive Power," by Major E. F. Green.
February 17. Civil Aviation Service Corps: Annual Dance, First Avenue Restaurant, Holborn, London, W.C.1.
February 17. R.Ae.S. Lecture*: "Maintenance of Civil Aircraft," by Mr. H. L. Hall.
February 21-March 4. British Industries Fair.
February 25. Hampshire Aeroplane Club. Annual Dinner and Dance, South-Western Hotel, Southampton.
March 3. R.Ae.S. Lecture*: "Riveting Methods in Germany," by Dr.-Ing. W. Pleines.
March 4. Cambridge University Air Squadron: Annual Dinner, University Arms Hotel, Cambridge.
March 10. R.Ae.S. Portsmouth Branch Lecture: "Air Raid Precautions," by Sgt. Barnes
March 24. R.Ae.S. Portsmouth Branch Lecture: "Refuelling in the Air," by Sir Alan Cobham.
April 7. R.Ae.S. Lecture*: "The Manipulation of the Boundary Layer," by Mr. E. G. Richardson.
April 21. R.Ae.S. Lecture*: "Factors Controlling the Development of Electrical Ignition on Aero Engines" by Dr. G. E. Bairstow.
June 4-7. Yorkshire Gliding Club: Whitsun Open Meeting, Sutton Bank.
July 17 - August 1. Yorkshire Gliding Club: Open Contest, Sutton Bank.
August 7-21. Yorkshire Gliding Club: Instruction Course, Sutton Bank.

* All these lectures take place at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1., beginning at 6.30 p.m.

COMMERCIAL AVIATION



REFUELLING EXPERIMENT: For some time experiments have been going on at Ford aerodrome under Sir Alan Cobham's direction. In this photograph the Short *Cambria* is being refuelled by the A.W.23 used for the work.

THE WEEK AT CROYDON

Buffeting—Meteorological and Municipal : Fire-Proofing : Very Slow Motion

THE rigger who got caught up in the hurricane and landed a mile or so away caused considerable confusion in local sporting circles by claiming the long-jump record. Much the same applies to these gale-inspired commercial air records of which we have had a glut lately. Claimants should be compelled to state the journey time in the other direction and then we should not hear so much from them.

Looked at logically, the blue riband of the Channel is about as attractive as a puppy-chewed bonnet ribbon, and not of much more practical use. If a record-breaking machine starts to schedule and takes forty minutes off the journey time it is apt to be a poor show, and the older companies try to keep schedule by opening up against head winds and throttling down for tail-gales.

I remember a passenger brought in here about half an hour too early who just played the deuce about it. He had asked his wife to meet him in the car, and what with sale-time shopping and her profound conviction that these machines were always unpunctual, she was half an hour late anyway according to the company's time-table. The man could not 'phone his wife, and therefore he spent an hour gnashing his teeth so as to make the newspaper kiosk vibrate on its not too good foundations. Another case was that of the man who actually liked flying, and who said he had paid for two and a half hours of it, fares being based on mileage. He fiercely demanded a handsome rebate because he had been deprived of forty minutes' flying.

A local bench of stipendiary what's-is-names ages ago decided that a fifty-year-old airline manager with airport offices was not to be trusted to handle a Guinness in the main-hall buffet. A dipsomaniac passenger, however, with no responsible job, could knock back a dozen double Scotches in the buffet. I have never quarrelled with the logic or the wisdom of this decision. You see, I have seen the magistrates all in a row on their bench, and I realise that it's the sort of decision to expect. They occasionally send myrmidons of their own standard of intelligence, to wit, one unsmiling inspector backed by a "Fred Emney"-type sergeant. The inspector asks perfect strangers if they are members of the staff, and if, being G.H.Q. or staff of the local mental institute, they dazedly mutter "Yes." I suppose Sergt. Emney puts them through a mixed course of P.T., ju-jutsu and third degree.

The legal point arises as to the position of a member of one of the operating companies, also a passenger by air. May he have a drink before leaving or does the disgrace of being connected with a low profession still hang about him in the minds of the enlightened magistracy?

Stirring times we live in, to be sure. On January 18 the K.L.M. London-Berlin service carried Gen. Tsiang, of China, on a mystery mission—which may have been connected with the opposite of the mission of two other passengers aboard the same machine, Mr. Lloyd and Major Frazer, respectively Under-Secretary, Home Office, and Air Raids Precautions Department. They were off to see how these things are done in Berlin and in Paris, in both of which cities they *are* done, not merely achieved on paper and by means of rhetoric.

Somebody might have hinted that charity begins at home. Croydon aerodrome, most vulnerable spot in Britain and probably the first place to go up in flames, has never seen an A.R.P. officer, has never seen a gas mask and knows naught of decontamination except when "Works" falls into the drainage system and is sprayed by "Bricks" with 30 over-proof carbolic. As for fire risks, we are fine. Our engine, with its two left-hand

asbestos gloves, its alert staff (provided he is not at his tea) and its hose, which really acts beautifully unless there is a tight true lover's knot in it, is the admiration and joy of the fire-fighting services of Europe. Its wheels, they say, are square from long idleness.

The flying machine is constantly proving its humanitarian excellences, and suffering humanity has once more been relieved by its means. It seems that in the Dutch E. Indies they have been drinking Japanese beer, which, presumably, is a fairly close imitation of the real thing. Now they have decided to drink beer from Holland, but they are short of metal bottle-stoppers. K.L.M. runs a 5½-day service from Amsterdam to Batavia thrice weekly, and 100,000 of what the Japs will excuse me for calling "nippon" stoppers (made in Bremen, I am informed), are being hurried out by air to the parched and suffering Colonists. *Prosit!*

Nature works in mysterious pulsating rhythm—responsible for the rise and fall of sap in trees, the ups and downs of the lift boy's life, the boom in Kaffirs balanced against the depression over Iceland, and the portentious fact that horses' feet go clippety-clop not cloppety clip. One minute Brer Bear goes roaring through the forest hitting folk for six, and the next he's totally torpid in his hybernaculum. So, too, some Government departments, in a frenzy of zeal which altogether outruns discretion, will erect misplaced pylons in a single night and, contrariwise, will do rather less than nothing about the Air France and K.L.M.-Sabena hangar, unroofed in part so long ago as November 26, of last year. Soon after the accident which nearly burned up the hangars, the authorities threw a casual tarpaulin over the unroofed portion and, it seems, neglected to fasten it down properly. It blew away a couple of days later and Works and Bricks remarked, "Well I never, did *you* ever, George?" Since then the wind and the rain have been about as inclement inside the hangars as outside. Sharp tiles and large pieces of charred rafter have fallen within and have been blown over a considerable area outside where aeroplanes taxi and park. Other wind-blown debris has made holes in parts of the glass roof so that new water leaks have appeared. The hangar doors jammed at the time of the accident are now partially open, so daily movements of machines in and out have become major sleight of hand tricks.

At least one machine has been damaged through this cause and a service delayed. Another aspect of the case is its anti-aviation "propaganda value," for the official Air Ministry guide has to conduct many parties of visitors daily past the twisted and fire-blackened hangar doors and invariably he is questioned about the occurrence. Any sort of temporary repair would have obviated all the harm which has certainly been done in this way. Incidentally, anyone who cares to protect his head from falling debris with an up-ended fire bucket will see, on entering the hangars and looking up through the gap in the roof, a number of half-burned rafters, so insecure that they actually move in the breeze.

I understand that recently the question of responsibility for possible damage to personnel and aircraft was raised with the authorities. At once the aloof attitude to the ills and hardships of mere mortals (albeit tenants who pay regularly) was dropped and a fierce disclaimer of all responsibility was forthcoming, despite certain clauses in accommodation contracts which, I fear, the authorities have overlooked. A. VIATOR.

The Ensign Flies

ON Sunday the first of the A.W. Ensigns was taxied up from the Armstrong Whitworth shops at Hamble to the aerodrome, where quite a large crowd of spectators congregated to the considerable dislocation of local traffic.

During the day various taxying and brake tests were carried out by the test pilot, Flt. Lt. Turner-Hughes, and on Monday morning at 10.50 a.m. (and at long last) the machine was taken out to a corner of the aerodrome which provided the longest possible take-off run. Flt. Lt. Turner-Hughes, accompanied by Flt. Lt. Greenwood, an assistant A.W. test pilot, then made four preliminary runs before actually leaving the ground on the fifth of these, after a run of approximately 16 seconds. This first flight lasted a quarter of an hour and the compass was then swung preparatory to a cross-country flight to the new Coventry aerodrome, where the complete tests will be made.

New Cloud Flying Regulations

WITH the increase in civil and service flying the system of cloud flying areas which was detailed in *Notice to Airmen* No. 47 of 1935 has now been superseded, and another *Notice* (No. 8 of this year) explains the new regulations and what is to be known as the "directional system." This has been developed in order that all flying in cloud or in conditions of bad visibility shall, as far as possible, be subject to a uniform system of control, and for the purposes of the regulations these conditions are deemed to exist when the horizontal visibility is less than 1,100 yards.

The directional system—which in some measure resembles the often-suggested layer-flying system—will apply by day and night over the whole of the country except over those areas which are already covered by the existing traffic control measures for transport flying. According to this new system the air space between the heights of 3,300 and 18,600ft. above sea level is divided into four horizontal zones, each of which is again divided into layers of 300ft. Definite magnetic courses are allotted to these separate layers. In other words, pilots must, according to the course which they wish to fly in bad weather conditions, choose one of certain operational heights. The airspace below the minimum height and down to 1,500ft. is free for either rapid ascents or descents, or for flying according to arrangements made with the control concerned, while unregulated flying may still be carried out below 1,500ft.

A special course-height indicator for use with the directional system will be made available in the near future, this indicator permitting immediate calculation of the specified magnetic courses and heights above sea level. On the backs of the indicator the three civil flying areas are shown on a small map and the regulations concerning these are briefly explained.

Linking Up Europe

AT a very pleasant and informal little party held by Air Commodore P. F. M. Fellowes last week we had a chance of meeting Lt. Col. G. A. Vaughan, D.S.O., and his colleague, Mr. Richard Watham, in whose honour this party was actually held. They had only just arrived from America, and the purpose of their visit to Europe is chiefly in connection with development of the use of the Link Trainer in England. They hope, however, during the short period of their stay to visit all the important European capitals. Lt. Col. Vaughan served with the Royal Air Force during part of the last war.

The trainers used in this country are actually being assembled in Canada and the total order exceeds 150. At the moment the Air Ministry has sixteen of them and British Airways one, while, as an instance of the Link's world-wide use, there are now eighteen in action in Japan. Incidentally, the crew of the record-breaking Mitsubishi monoplane *Divine Wind* are said to have included fifty hours' blind training on the Link before starting on their flight.

TWO FIRSTS: The Short Mayo composite just free of the Medway on its first flight—Messrs. Lankester Parker and H. L. Piper in dual charge. Other pictures appear in the photogravure supplement in this issue. This historically important first flight was followed by another, that of the Ensign, a few days later, at Hamble, Southampton.

Commercial Aviation

Ju 86s for S.A.A.

TWO more additions to the South African Airways fleet arrived at the Rand airport from Germany on December 22. The new machines are of the Junkers Ju 86 type. They left on December 12 and made the flight by easy stages. Two more of the consignments of Junkers 52's and 86's ordered some months ago by South African Airways were expected to arrive before the end of last year, and four more are due this month. It is hoped that delivery of the entire consignment will have been completed by the end of March.

The French Transatlantic Fleet

IT has been announced that the French Government has now granted the necessary credits to Air France-Transatlantique for the purchase of new flying boats for use on the French North Atlantic service. The flying boats, which will become the property of the company, are the Latécoère 521 and 522, the Farman 2231 *Laurent Guerrero* (which recently flew to Chile in record time), one Farman 2230 with airtight cabin, and two further Farman 2230s. There is also the four-engined 40-tonner CAMS 161, the new prototype which is under construction Other machines, the Latécoère 631 and the Lioré et Olivier 49, exist so far only on paper, but their possibilities are being carefully considered with a view to series orders.

African Quid pro Quo

THE concession asked for by Wilson Airways to Kosenyi (feeding the Kilo-Moto gold mines), Costermansville (Lake Kivu) and Usumbura (Lake Tanganyika), will, it seems, be granted only on condition that Sabena may have complete rights at Kano, Nigeria, on the main Congo route. The crossing of the Congo by the South African Airways has not yet been authorised by the Belgian Government, and the granting of permission to operate between Leopoldville, Windhoek and Johannesburg is not considered by Sabena to be sufficient compensation for this passage. Incidentally, Air Afrique's new Blochs will be used only between Algiers and Banqui.

The New Aviation Maps

WITHIN a short time the first six sheets of the new ordnance survey 1/500,000th aeronautical map will be published. These sheets will cover Wales, the Midlands and the South of England; the rest of the series should appear during April.

The maps are drawn on a modified polyconic projection, and each sheet covers, with an over-lap, the same area as that of a quarter sheet of the International 1/1,000,000th map. The symbols providing air information are those adopted by I.C.A.N., and, though the heights are given on the maps, there are scales of kilometres as well as of statute and nautical miles.

Empire Air Mail Troubles

AS might have been expected, a certain amount of trouble has been caused during the last few months through the incorrect stamping of the letters and packets which are now automatically carried by air to South Africa.

The Federation of British Industries has issued a warning statement in which it is explained that many South African firms have received their mail prepaid at the old rate, and have naturally been called upon to pay a surcharge of double the amount of the deficiency. In one case an unfortunate person was charged as much as 12s. 6d. The rate is, of course, 1½d. per half ounce (postcards 1d.), and every letter, however stamped, is carried by air, errors of stamping being rectified expensively at the other end of the journey. This flat rate will shortly apply to letters and packets sent also to India and Australia.

New Zealand Co-ordination

THE three operating companies in New Zealand, Union Airways, Cook Strait Airways and East Coast Airways, which are closely associated with the Union Steamship Company, as well as the long-established independent concern, Air Travel (N.Z.), Ltd., have, since November 30, co-ordinated their different services. In other words, the four companies have arranged their time-table to suit the traveller on the network as a whole.

Union Airways operate between Dunedin, Blenheim, Palmerston, New Plymouth and Auckland with three D.H.86s and three Electras; Cook Strait Airways between Wellington, Blenheim, Nelson, Westport and Hokitika with four D.H. 89s; East Coast Airways between Palmerston, Napier and Gisborne (a difficult run) with two D.H.84s; and Air Travel between Inchbonnie, Hokitika, Franz Josef and Haast River with two D.H. Fox Moths and a D.H. Dragonfly.

Air France's New Dewoitines

AIR FRANCE has now taken delivery of five of the twenty-two Dewoitines 338s which were ordered last summer; two more are almost completed. The three engines are 650 h.p. Hispano V nine-cylinder radials.

Meanwhile, the forty-passenger Dewoitine D630s have been abandoned in favour of a fast passenger machine to be known as the D.342, which is to have twenty or twenty-one seats, or, alternatively, twelve sleeping bunks.

The Guinea Service

SOME time ago it was announced that W. R. Carpenter and Co., of Sydney, were the successful tenderers for a 2,522-mile service between Australia and New Guinea which is to be operated weekly in each direction.

Carpenters, using D.H. 86 B machines, will operate at a subsidy rate of 1s. a mile—a figure which represents an income of £65,572 per year. The service should be started early this year, and the company has already taken delivery of the two D.H. 86 Bs required, while a reserve machine will shortly be leaving Hatfield.

A New Anti-icing Substance

A NUMBER of useful features and advantages are claimed for a new anti-icing material known as Avigel, which has been developed by Dr. Harry Barron, an industrial consultant of 8-9, Bishop's Court, Chancery Lane, London, W.C.2. He has apparently been working on chemical methods of ice prevention for some years, and the new substance appears to have been satisfactory in both laboratory and air tests.

Among the claimed advantages are that it is economical in use; that it can be applied by spraying or brushing; that it is elastic rather than plastic; that its effects are lasting (laboratory tests have given it a life of 100 hours at 40° frost); that is not soluble in water; and that it is easily removed when necessary.

We hope in due course to have a chance of seeing this substance in action, and until that time we merely record the claims put forward.

The Congo Service

THE three Savoia-Marchetti S.83s ordered by Sabena for the Congo service should be delivered next month and will be in regular service in May or June. Three Junkers Ju52s have been ordered for the internal Congo services, and when these are in service Libenga will, it appears, replace Stanleyville as the central terminus.

It is possible that the Sabena services will be running every week instead of fortnightly before the end of the year, though this will apparently depend on the Aeromaritime plans. Needless to say, any such change will need to be made in co-operation with Air Afrique, with whom the service is shared. Aeromaritime are at present running their Dakar-Pointe Noire service on a weekly basis. The Sabena branch line, linking Elisabethville with Kivu, may be opened in May or June.

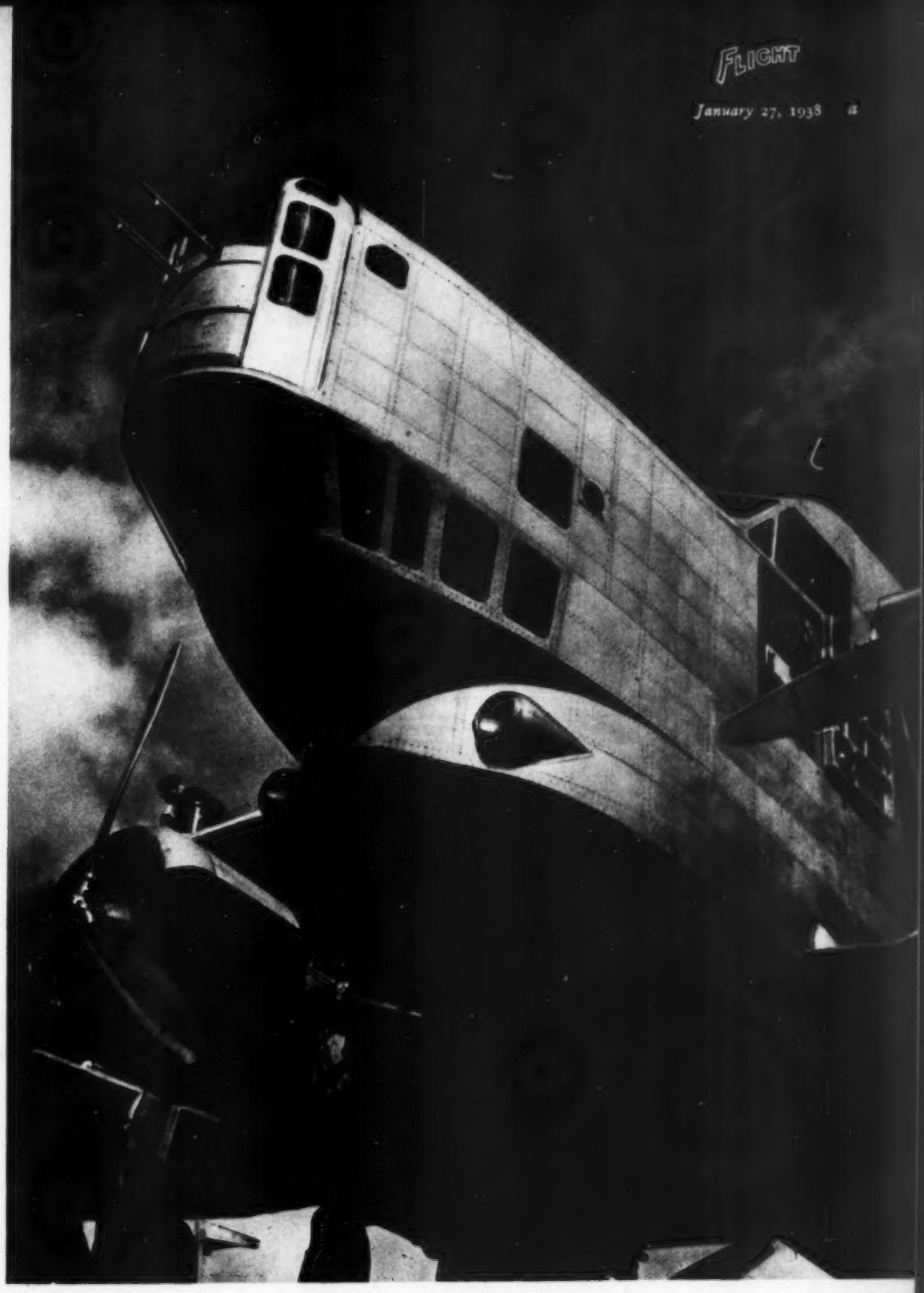
There is, it seems, no truth in the suggestion that Sabena's operations on the trunk service had been temporarily suspended owing to minor subsidy problems.

European "Fourteens"

WITHIN a very short time K.L.M. should be taking delivery of their first Lockheed 14 or Super Electra, examples of which are also due for Trans-Canada Airways and K.N.I.L.M.

Of the K.L.M. 14s it appears that one may be used this year on the company's North Sea service to Doncaster and Liverpool, for which the type is considered more suitable than the Douglas D.C.2 used last year. At any rate its use on this service would be of definite prestige value. Incidentally, with the opening of the new Ringway aerodrome in April or thereabouts it is probable that the service will resume its originally scheduled stop at Manchester, where Barton was considered too small. At least one of the other K.L.M. 14s will be used in and from Netherlands Guiana, South America, where Fokkers are at present in use. It may be remembered that the first F.18 was flown over the South Atlantic at the end of 1934.

From all accounts the performance of the production 14 is well up to expectations, though some slight disappointment is felt about the effect of the Fowler flaps. Apparently an exceptionally good full-load take-off can be obtained at a certain risk—that of engine failure immediately after leaving the ground. For a really short take-off the flap position must be such that single-engined flight is not possible. So the pilot has the choice between a longer take-off run and the very remote risk of engine failure before a speed is reached at which the flaps can be safely retracted.

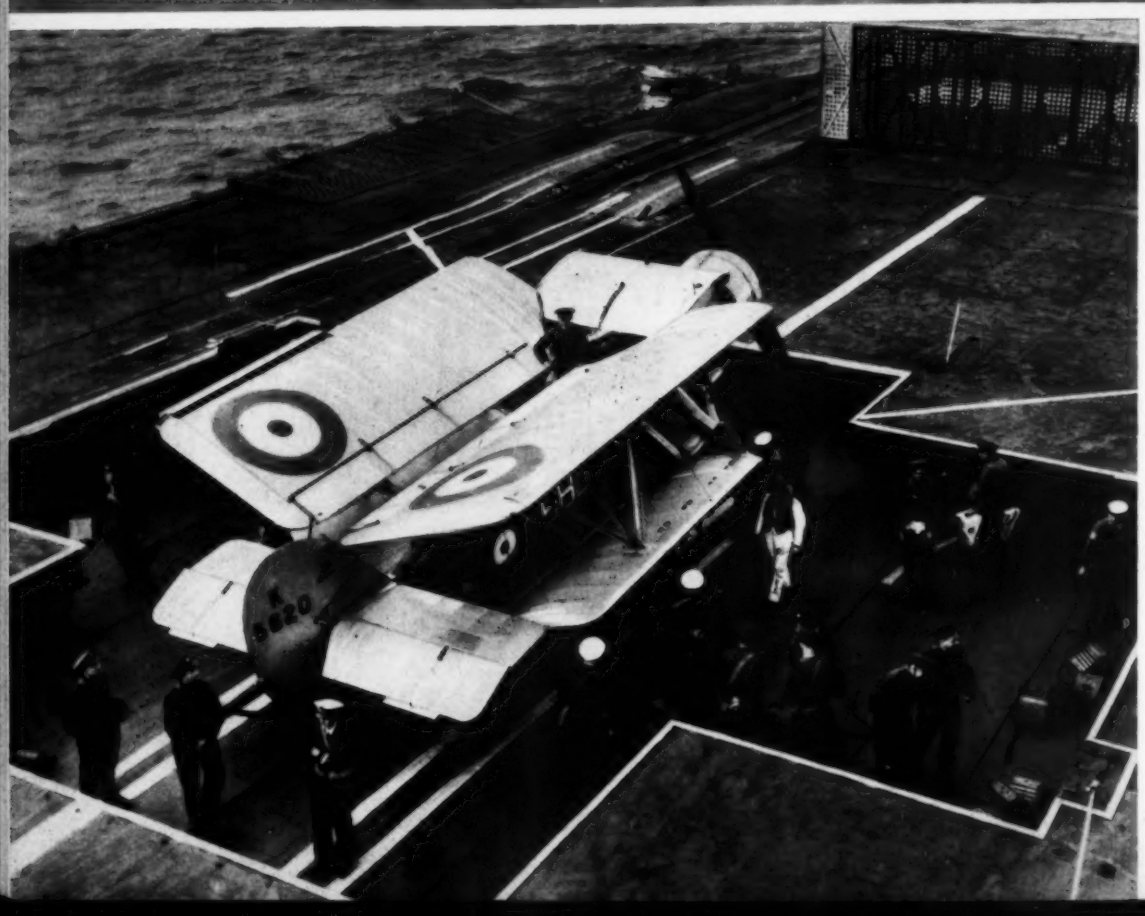


HEAVY BOMBER

Lacking the sleek beauty of such types as the American Boeing YB-17, France's four-engined Farman heavy bombers (Gnome-Rhone K.14) nevertheless have a "rugged grandeur" all their own.

WITH THE FLEET

The white cross shows on the carrier's superstructure, signifying "O.K. to land-on"; the Shark nears in for the landing, touches down; the deck landing officer raises his flags ("Arrester gear successfully engaged"); the Shark decelerates rapidly; handling crews shepherd her to the lift; latch pins are withdrawn, the wings fold back; and down goes the Blackburn into the bowels of the "Courageous."



Airports Conference Papers

GRASS-DRYING on AERODROMES

An Economical Method

By CHARLES M. NEWTON

"Farmer and Stock-Breeder" photograph.

The "Cutlift" combine, referred to by Mr. Newton, cutting and loading grass for the drier. Note the almost lawn-like appearance of the mown area in the foreground.

I THINK my first duty should be to warn aerodrome owners that it is not yet established that there is any large amount of money to be made from grass-drying.

All I claimed in a recent discussion was that, by installing a grass-drying plant, we had reduced the cost of maintaining an aerodrome.

In the past, the practice of most aerodrome owners has been to cut the grass a number of times during the summer with gang mowers, leaving the cuttings lying on the ground. It has always seemed to me that this was an uneconomical and wasteful proceeding, not only from a local, but from a national point of view. It is estimated that in this country something like 50,000 acres of land which previously produced food in the form of meat, milk or grain are now, as landing grounds, devoted to a use that is entirely non-productive from the food point of view. So, if we can conserve the grass which grows on aerodromes and turn it into feeding stuffs, we are adding to the food supply of the country, with a corresponding decrease in the amount of feeding stuffs imported from abroad.

It is very difficult to graze a busy aerodrome, and it is usually too dangerous to aircraft to allow the grass to become sufficiently long to be made into hay, so that it was a natural evolution that grass-drying should be looked to for a solution of the problem of not only maintaining the surface, but of producing food from aerodromes.

Mr. C. M. Newton, who read this paper at the Airports Conference, is the new chairman of the Aerodrome Owners' Association

Practical grass-drying dates from 1926, when the late Professor T. B. Wood and Dr. H. E. Woodman, of Cambridge, drew attention to the high feeding value of young, short grass, and showed that this could be preserved almost unimpaired by artificial drying, and that dried grass would replace highly concentrated cakes for beef or milk production. Since that date much progress had been made and a number of improvements have been effected in the design and manufacture of grass-drying plant, but there still remains a good deal of experimental work to be done.

Apart from the question of improvements in the plant, I also feel that it is going to take some time to persuade farmers that dried grass is worth the price it is necessary to charge for it, although, apart from the cost, the actual price is fixed on analysis, and arrived at by calculating the amount of purchased cake it will replace, plus an added value for the vitamins and minerals which are present in the dried grass and not in the cakes. A ton of good-quality dried grass (17 per cent protein, 58 per cent. starch equivalent) is worth, on its replacement value only, about £6 10s. per ton. The cash value of the minerals and vitamins may be put at £1 per ton, and this gives a total value for the dried grass of £7 10s. per ton.

Value of Dried Grass

I know that a number of aerodrome owners have been contemplating the installation of grass-drying plant, and I know that many hesitate, wondering if there will be a market for large quantities of dried grass if it is produced by most aerodromes in the country. In view of the fact that the British farmer buys something like £30,000,000 worth of cake, meals and feeding stuffs directly or indirectly from abroad, it is hardly likely that the production of dried grass from aerodromes will materially affect the market. From the national point of view, too, if dried grass is produced from aerodromes the present position will be quite reversed. Aerodromes are, at present, looked upon as wasteland; when dried grass is produced from them they will yield more than the average grassland in this country. The yield from grassland is judged by the total protein and starch equivalent produced, and dried grass from an acre will produce about 10 cwt. protein and 35 cwt. starch in a season, whereas a crop of hay produces only about 3 cwt. protein and 9 cwt. of starch in a season.

The feeding value and advantages of dried grass, however, is hardly the subject for this paper, and must be left to the agriculturists and scientists. Having sketched the history of dried grass and described the produce, I will now turn to its application to aerodromes, which is the subject in which we are specially interested.

Having decided that you wish to install a grass-drying plant on your aerodrome, the first thing to do is to choose the site for the building to house the plant, which will measure about 80ft. x 25ft. This must be placed on the perimeter of the aerodrome, where it will not obstruct flying approaches, but, on the other hand, it must be as near to electric current as possible, and also have a good access to the road for delivery of the coal or coke and the removal of the dried grass.

The next matter to consider is the make of drier, and there are a number on the market, all of which have their special appeal. I can only say that my own experience has been acquired with that made by Ransomes, Sims and Jefferies, of Ipswich, an example of which we decided to install at Sywell Aerodrome. The drier consists of a steel casing 30ft. long, in which is a floor, made of a series of perforated plates, over which the grass is drawn by a conveyor, which is formed by cross-bars connecting together two endless chains. The drier casing is divided into two chambers. Two fans driven by an electric motor are provided and hot air is supplied to each chamber by a separate fan at the correct temperature for each stage of drying. The air supplied to the first chamber is at 300 deg. F., whereas that supplied to the second is at 220 deg. F. The fans draw their hot air from a furnace, and the temperature of the hot air is controlled by a series of dampers. A system of recirculation is used in which air from the fan supplying the second chamber is passed up through the mattress of grass and recirculated by ductwork back to the furnace for reheating. The furnace is fed by an automatic stoker

Marketing the Grass

Having decided to install your drier, the next problem to consider is the marketing of the produce, and here you must be governed by local conditions. If there are a number of dairy farmers in the neighbourhood who are likely to buy dried grass, then a baler may be installed. With this the dried grass is compressed into trusses, weighing on an average 70 to 80 pounds. If, however, there is not likely to be a local demand, it might be better to install a grinder, by which the dried grass is ground into meal, put into bags and sent by rail to cake manufacturers, etc.

To return to the cutting of the grass: this will now be done by a tractor-drawn "Cutlift" combine, by which the grass is cut, taken up an elevator and dropped into a trailer behind, in one operation. The great advantage from a flying point of view is that the grass is not left on the ground to be an obstruction, like hay, and the somewhat large cutting contraption is easily seen from the air. The grass is cut when it is from 5 to 8 inches long, about a third of the length at which grass is cut for haymaking, and the continual cutting of the young grass greatly improves the surface of the aerodrome, and gives it a lawn-like appearance. It will be realised,

"Farmer and Stock-Breeder" photograph.

The drying plant being fed with the mown grass The dried grass has a high value in the market for cattle-feeding stuffs

of course, that the grass cannot be continually cut and taken off without putting something back in the nature of fertilisers, and the prudent aerodrome owner will set aside a sum of money for the application of fertilisers annually.

It will be realised that the grass-drier is merely a machine for evaporating water, and the cost of drying varies enormously, as fresh grass may contain as much as 90 per cent. or as little as 50 per cent water, and this makes a vast difference to the cost.

The labour required consists of two men on the drier, one feeding it and the other baling the finished article, and a man and a boy on the tractor and trailer. The labour is easy to train, and can become proficient in a few hours on the drier. One difficulty with the labour, however, is that it is only required from April to October, so that, if possible, men should be engaged who have a winter job.

With regard to cost, the capital required for a drier and equipment capable of producing 3½cwt. of dried grass per hour is about £2,500, including housing of the drier, and allocation of a small amount of working capital for labour, fuel, etc.; as the sales of dried grass commence in the winter, there is usually no return during the drying season.

With regard to running expenses, our season last year was so short, owing to delay in completing the drier and getting the electric current to the site of the plant, that it is no true criterion of the cost of production, but after this summer's experience I shall hope to have accurate figures.

THE AIRPORTS CONFERENCE BANQUET

A FEW quite startlingly frank remarks were made by at least one speaker after the dinner of the Aerodrome Owners' Association at Grosvenor House on the first day of the Conference.

As an ex-Secretary of State for Air, Lord Londonderry (who, as president of the Association, was in the chair), must possess a good understanding of Air Ministry methods and opinions; and in his reply to the toast of the A.O.A., proposed by the Under Secretary of State for Air, he was certainly outspoken, ironically amusing, and to the point in his demand for a subsidy for aerodrome owners. Whether or not such a subsidy would be a good thing, Lord Londonderry made the very best of all the arguments in its favour.

Lt.-Col. A. J. Muirhead, the Under Secretary, spoke of the notable advances in the number of civil aerodromes constructed during the last four years and in the membership of the Association, which had increased by 60 per cent. in the last two years. Whereas four years ago there were only sixteen licensed municipal aerodromes there were now thirty-five, while ten were in course of development and fifty other private aerodromes were in use. He said that the layman probably did not realise the amount of ancillary equipment necessary in airport operation and wondered whether, in asking for a special subsidy, the airport owners realised fully the cost to the Air Ministry of the radio, meteorological and control equipment which had already been provided or promised. This cost was in the vicinity of £135,000 a year. He pointed to the need for economic health in air transport generally and said that the pros and cons of Governmental assistance must be weighed up very carefully. The formation of Volunteer Reserve Schools would help the economic situation where many aerodromes were concerned, and work was now going ahead in the necessary licensing of airlines.

In his reply, Lord Londonderry referred to the days when he himself had met deputations from the S.B.A.C. and he did not remember saying then any more than was essential in the interest of good behaviour. Everyone knew that in 1931 the Government had sacrificed everything for stability, and he hoped at the time that the Old Lady of Threadneedle Street, having been restored to health, might become air-minded. The sponsors of aerodrome projects really believed that their work provided the foundation of air transport, since without aerodromes machines obviously could not fly, but he did not see why private individuals should be expected to put their hands in their pockets. As it was, aerodromes were still few and far between, in spite of Lord Mottistone's demand long ago that there should be one every twenty-five miles. He did not believe that the railways intended to absorb all the services and then neglect them. The amount spent by the Government on radio services was a mere fleabite in comparison with that spent in other directions, and unless the owners received something more substantial it seemed that civil aviation in this country would come to a standstill.

The Important Side

Councillor J. Bateman, the retiring chairman of the Association, proposed the toast of the guests in his customarily forthright Yorkshire manner, and stressed the importance of the social side, reminding his hearers that twelve thousand visitors passed through Schiphol, for instance, every year. The aero clubs were useful, but it was difficult to make the layman understand the problems involved. He was glad that the A.O.A. was concerned only with the civil side, which would be the only important one in years to come.

Mr. J. G. Gibson, Director of Home Civil Aviation, replied in a few words and said that the Air Ministry was fully alive to the value of the A.O.A. He mentioned the importance of full co-operation in "harmony and patience."

Finally, the new chairman of the Association, Mr. C. M. Newton, of Sywell, proposed the toast of the president, saying that he was an aerodrome owner himself and was therefore exceptionally well-fitted to fight their battles.

HATFIELD GOES TO OLYMPIA

FOR the annual staff dinner of the De Havilland aircraft division the organisers had the original idea of holding the dinner at the Addison restaurant, Olympia, the idea being that the diners would afterwards visit the Fun Fair. The theory was good, but, like many other theories, it did not quite work out in practice. It was nearly 11 p.m. when the party rose from the tables.

The chief speaker of the evening was F/O. A. E. Clouston, A.F.C., who gave a short but well-delivered chat (it was too informal to be termed a speech) on his flight to the Cape and back with Mrs. Kirby-Green in the D.H. Comet. The flight, he said, was carried out to a carefully prepared schedule, and neither aircraft nor engines gave the slightest trouble. At Broken Hill, on the return flight, the machine was standing in pouring rain for hours, and water getting to the magnetos not unnaturally caused some delay in starting. This gave rise to a story about engine trouble.

Mr. Clouston's account of his landing at Cairo on the homeward flight was amusing. He was by then getting fairly fatigued, and knew from experience how easy it is to "land" twenty feet up. Consequently he "put the wheels on" at 100 m.p.h. The machine resented this and ballooned into the air again. "However," Mr. Clouston said, "I had plenty of fuel on board, and I was determined to keep trying until the fuel gave out." Ultimately he got the Comet down safely.

Of his forthcoming flight to New Zealand, Mr. Clouston said that it would also be made to a schedule. He intended to fly at cruising speed all the way, so that it was doubtful if he would be able to beat Scott's record (Scott was flying "all out"), but he would have a good try. Also, his engines were of lower power than those fitted on Scott's flight.

Mr. A. S. Butler was in the chair, and outlined the progress of the De Havilland company during 1937. The speech was, naturally, almost identical with that given at the airscrew and engine divisions dinner recently, which was reported in *Flight* of January 9. Mr. Butler read telegrams from the De Havilland companies overseas. Mr. W. Pickett proposed the toast of the guests, to which Mr. Clouston responded.

LONDON'S TERMINAL

Making the Best of What We Have : Some Suggestions for the Improvement of Croydon

AT the present moment it is still uncertain whether the Fairlop airport scheme will be carried through, and in the meantime it is still possible to consider other alternatives.

Now that the Government has purchased Heston airport it is reasonable to suppose that this site will be extended in the manner which was suggested by Airwork themselves some time ago. In this plan the boundary was to be extended in a southerly direction as far as the Great West Road ; the present right of way was, of course, to be dealt with as far as the eastern boundary was concerned ; and the terminal group of buildings was to be razed to the ground and a new group erected on the northern boundary, where, also, a suitable railway branch-line would be laid down.

Consideration of the entire suggestion prompts one to wonder why a somewhat similar, if more costly, scheme could not be carried into effect at Croydon in order that this airport might be equipped to deal with any volume of traffic likely to appear during the next few decades. Needless to say, such a development scheme would cost at least half as much as that necessary for the layout of an entirely new air centre, but during the past fifteen years the public has learnt to think of Croydon as London's aerodrome, and mental habits of this kind are not easily broken.

Presumably no one would consider the removal of Purley Way and taking in the ground behind it, and in any case the fact that the edge of the aerodrome would then be on the hill-side makes this idea of improbable value. Alternatively, it would be necessary to buy up and demolish the houses on the western boundary, from the direction in which ultra-short-wave approaches are at present being made. The country beyond this area is reasonably flat, and in every way suitable as an approach line. There would then be at least one run suitable for present and possible future conditions.

Now that blind or almost blind approaches are the order of the day, the Air Ministry might at least set somebody to work on the job of reducing irregularities which make all the difference between a successful and unsuccessful bad-weather landing. Even the stoutest "tricycle" will wilt if it is used seriously at the termination of a blind approach on to the surface as it is at present. Probably half a dozen expensive accidents have occurred with medium-sized machines in the last year at Croydon during or immediately after the landing, and the cause in almost every case has been the nature of the surface on which the pilot is expected to put down while his landing vision may be almost entirely and suddenly obscured by snow or heavy rain.

The Next Best Thing

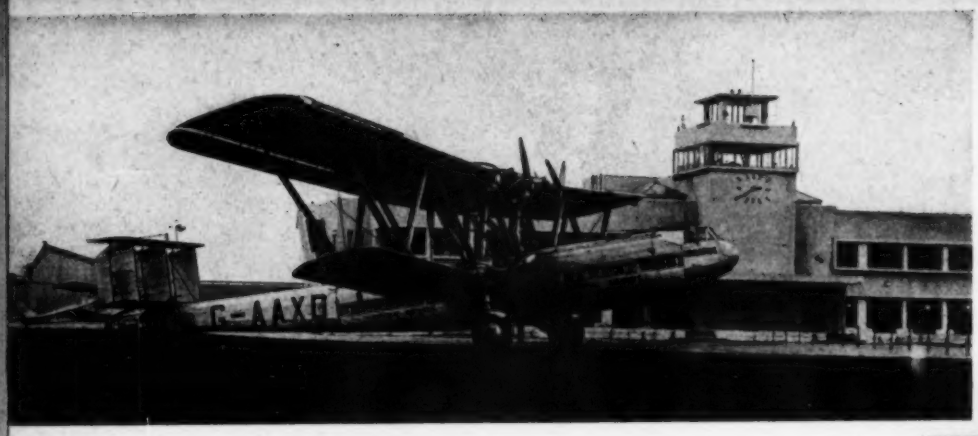
Finally, if no one can be encouraged to spend more than a few hundred pounds, work might at least be started on a really adequate blind take-off and landing line or lines—preferably of the sunken Neon strip type. A transport pilot of my acquaintance has suggested the laying out of a sort of multiple arrow pointing in the take-off direction so that if, by any chance, a pilot leaves the main line he has only to follow any other line which is crossed in order to return to it. Different coloured lighting could be used to indicate the distance of each arrow-head from the aerodrome boundary.

There is no need to mention the entire inadequacy of the present accommodation, and something will obviously need to be done about this within a very few months. The way in which the Berlin authorities have tackled their own problem should be a sufficient incentive to us.

H. A. T.

SNAPPED at the AIRPORTS CONFERENCE

Four representatives of two well-known west-country airports. On the left, Cardiff : Mr. G. H. Whittaker and Councillor Williams. On the right, Bristol : Alderman A. A. Senington and Councillor V. J. Ross.



The portrait below is of Mr. Volk. On the left is Shoreham Airport, of the committee of which he is chairman; the photograph was taken when *Horatius* landed there during recent bad weather.

Airports Conference Papers

AIRPORT ORGANISATION and MANAGEMENT

Some Practical Points for Owners : Catering for the Air Traveller and the Casual Visitor—By M. H. VOLK, F.R.Ae.S.

In this paper, which he read before the delegates at the Airports Conference last Thursday, Mr. Volk (who is chairman of Brighton, Hove and Worthing Airport Committee) reminds owners that an airport should be something more than a mere place for the picking-up and setting-down of passengers; like "Flight," he strongly advocates the provision of pleasant restaurant and other amenities to attract the general public and thus interest them in air travel.

The paper, as given here, is very slightly abbreviated.

THIS paper, of rather an encyclopædic nature, is written very largely from an aerodrome user's point of view, and by "user" is meant everyone from the owner of an important airline down to the casual visitor who visits the aerodrome because he or she is interested in flying.

The paper will not deal with the actual design of an aerodrome or its buildings, although naturally this will have to be touched on, but is largely based on the writer's own experiences, both at home and abroad, where one often finds that quite simple things which would add to the safety, comfort and general amenities of an aerodrome are lacking.

In addition, the needs of the professional and private pilot have not been overlooked, and in this respect the writer would like to acknowledge the assistance given by such well known and experienced pilots as Captain Olley, Lord Amherst, Captain Geoffrey de Havilland, Mr. Oliver Tapper, Flt. Lt. Clarkson, Flt. Lt. Colman, and others.

Whilst the paper may aim at an ideal and some of the suggestions be, perhaps, a little unorthodox, it does appear that a certain amount of imagination is required, or is at any rate permissible, in the organisation of an aerodrome.

With these preliminary remarks let us proceed to consider the subject before us.

Service.—It will, no doubt, be generally agreed that it is important to have a knowledgeable, pleasant and tactful receptionist, preferably a linguist, in charge of the enquiry counter in the main traffic or booking hall of the terminal building. This official, if rightly chosen, should be able to answer all enquiries as to the various facilities and air services available at the aerodrome.

Porters should also be available for the handling of passengers' luggage and other duties, and whilst it is the practice at some aerodromes for each airline company to provide its own porters, unpleasantness often arises through the staff of one company, perhaps rather naturally, refusing to be of assistance to other than their own passengers.

There is, therefore, much to be said for the porters being employed by and under the direct control of the aerodrome manager, which should result in all passengers receiving equal assistance and courtesy.

Unfortunately, in this case the whole expense falls entirely on the undertaking, but no doubt the difficulty could be overcome by making an appropriate charge to the various companies concerned.

Incidentally, whilst we are on the rather delicate matter of

Although on a large and elaborate scale, the fine Jersey Airport building has that cheerful and attractive air praised by Mr. Volk.

the rivalry that so often exists between airline staffs, it is to be hoped that more and more pressure will be brought to bear on the Government to remove the grave drawbacks that arise from certain travel agencies not being allowed to book passengers by all or any airline, but only those allied to certain vested interests. It is pleasing to note, however, that recently there has been a slight easing of this very unfair situation. There is no doubt that, in the public interest, such an unreasonable position should not be allowed to continue.

Telephone and post office facilities.—Full telephone and post office facilities as well as kiosks where papers and other sundries can be obtained should be available at all busy airports, and, incidentally, it would be a great convenience if passengers travelling by air could send wireless messages as one can from a ship. As a matter of fact, this idea is receiving the serious attention of the Air Ministry, but the difficulty appears to be the lack of a suitable wavelength, of which, apparently, there are very few available.

Outside information bureau.—Apart from the enquiry office at the aerodrome itself similar bureaux in central positions in the nearest town or towns could with advantage be established, where flights, by arrangement with the various operating companies, could be booked and all information regarding services and facilities at the aerodrome could be obtained. Here again the assistance given should be entirely unbiased.

Public notices.—Another most important point is there should be exhibited in the booking hall large notice boards clearly indicating the times of arrival and departure of aircraft on all regular services, and—what is of equal importance—a bulletin board showing any delays or cancellations and the reason therefor. This would often save much anxiety and inconvenience, not only to intending passengers, but to any friends who might be waiting to meet them at the aerodrome. Lack of consideration or frankness on the part of operators, has, to the writer's own knowledge, on numerous occasions caused a great deal of real distress and often much waste of time; certainly it does not tend to encourage those so shabbily treated to make further use of this latest mode of travel.

Passenger Insurance Facilities

Insurance.—The writer would also like to see it possible for air passengers to insure for a nominal fee at practically all aerodromes, on similar lines to the scheme instituted by Imperial Airways, and for many years by the railway companies, and it is suggested that there is a possible source of revenue in this direction by aerodrome owners acting as agents.

Since writing the above it has been interesting to note in the Press that airline travellers in the United States are being offered similar insurance. Policies, covering death, disability and so on, are issued for 5,000 dollars at the rate of 25 cents for each four hours' flying time, which is practically equivalent to the 1s. premium charged for similar cover over here.

Comfort.—Now for a few suggestions on how it would be possible to add to the general comfort of passengers and others using an aerodrome.

(a) The distance to be traversed by passengers to the aircraft on which they are travelling should be kept as short as possible, that is to say, the booking office, traffic and customs departments should be adjoining the departure platform, and one looks forward to the time when it will be found economically possible (as will be the case at certain large airports now under consideration or in course of construction) to have large canopies projecting from the terminal building under which waiting aircraft can be drawn up, thus enabling passengers to go aboard under cover.

(b) Adequate cloak room accommodation should be provided, available not only to those having business in the terminal building but also to casual visitors in the public enclosure.

(c) Incidentally, a small matter, but why not provide a few large wall-type ash trays, cinema-fashion, in the public part of your building, where passengers can dispose of their cigarettes, etc., before entering aircraft on which smoking is banned?

(d) Have you considered heating your hangars during cold weather for the comfort of the mechanics, sometimes in the vernacular called "pot wallopers" or "grease boys"?

Britain, generally speaking, is far behind the Continent in the provision of airport catering facilities. Above is a peep into the Tempelhof (Berlin Airport) restaurant.

Very expensive, you will say, for such inefficient heat-retaining structures; but what about a few localised blower-type heaters suspended from the roof, from which a certain amount of warmth could be directed on that part of the aircraft on which work is being done? Also, if necessary, they could be used for preventing the freezing-up of certain types of engines.

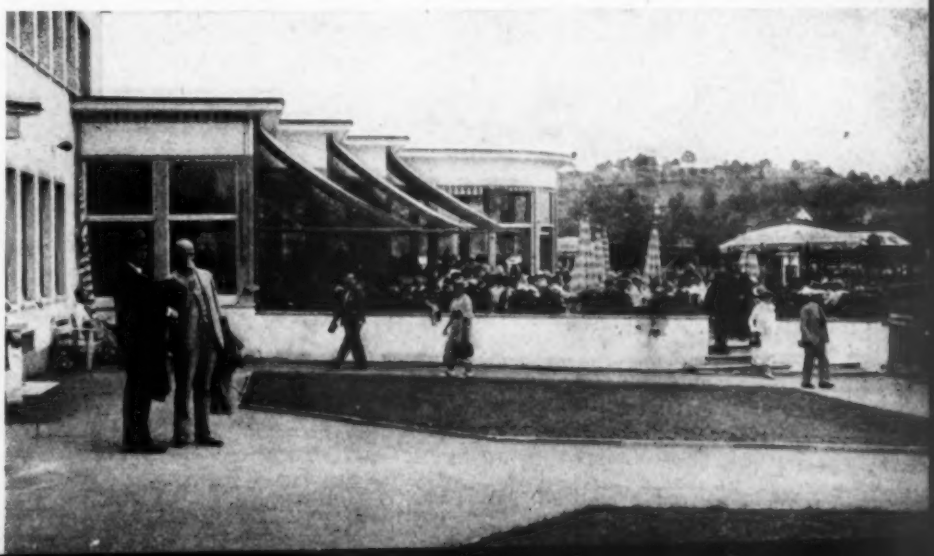
And now let us consider aerodromes in their relation to clubs, private owners, and pilots in general.

Flying clubs.—There is no doubt that civil aviation owes a great deal to the pioneering work of these clubs, and they are still doing noble and useful work at many aerodromes. But unfortunately from the club point of view, their activities have now to be kept more under control, owing to the slowly but ever increasing growth of commercial aviation and the new R.A.F. Reserve Schools.

It is also important that the general public should not gather the impression that the use of an aerodrome or its various facilities is confined to club members only. Should this point arise, steps should at once be taken to neutralise its possible negative effect on the general public.

Private owners and landing fees.—Let us now consider this very vexed question. At one time the writer was all for private owners being allowed free landings, chiefly on the score that the more their visits could be encouraged the greater the activity at the particular aerodrome they visited, with increased business in the way of sales of liquid and other refreshment for man and machine. Unfortunately, in actual practice these compensations as far as the aerodrome owner is concerned do not cover the proportionate expenses. Further, it should not be overlooked that nearly all private owners are club members and most clubs are in the fortunate position of receiving a subsidy, whereas the unfortunate aerodrome owner does not, yet is expected to do so much for so little recompense or even for none at all.

However, there is a scheme now under consideration by the Aerodrome Owners Association whereby flying members of the Royal Aero Club will be able to obtain books of tickets at reasonable rates entitling them to free landings at almost any aerodrome; this will avoid, to a large extent, the somewhat



A typical Continental outdoor airport café, with cheerfully coloured sunshades and blinds—Zurich.
(*Flight* photograph.)

Useful to the seeker of information and entertaining to the passenger whiling away his time—an elaborate European route map at Warsaw Airport.

irritating delays often caused by change-giving and other formalities on arriving at one's destination.

Ground transport.—It would also be a great benefit, not only to pilots but also to neighbouring towns, if a quick and fairly frequent means of transport and a system of hire-and-drive-yourself-cars were available at all aerodromes,* for it is not much use being able to fly from "A" to "B" in a very short time for the purpose of visiting a nearby town and then find that you cannot get from aerodrome to town, and vice versa, in the time at your disposal. What a problem these terminal losses are!

Let us now consider as briefly as possible other matters which would add so much to the general well-being of all concerned.

A list of telephone numbers of aerodromes within normal flying distance should be kept in the pilots' telephone box.

Liaison: There should be close liaison between the tarmac staff and the communication office, not only for the reporting of casual arrivals but for the purpose of assisting pilots, particularly foreign tourists, through the formalities and to render whatever assistance may be desired. This is particularly important when the various control offices and Customs are widely scattered, though nowadays there should be no excuse for such separation.

Comfort for Crews

A pilots' room should be provided and reserved for their personal use, for the changing of clothing, making-out courses, reports and filling up the many forms which, unfortunately, often fall to their lot.

Refuelling facilities. There is a rapidly growing tendency to replace or augment the usual overhead swing-arm petrol pumps by mobile refuelling units, operated by relatively unskilled labour, and which can be driven anywhere on the aerodrome. This avoids the somewhat cumbersome method of taxi-ing, often some distance, to the pumps, a process which is also liable to cause waste of time and dangerous congestion.

Next we come to safety precautions.

Landing area.—The question of properly draining and grading a landing area so that it does not easily become waterlogged should, the writer thinks, receive consideration under the heading of safety. When carrying out this work on new aerodromes, particularly those with heavy, slow-draining soil, it is suggested that the whole area should be regraded and finished off with a slightly domed surface, that is to say, one a little higher towards the centre than at the edges. The talk of "billiard-table flatness" may sound fine, but under certain conditions such an apparently ideal state may be all wrong. Incidentally, the new Singapore Airport has its landing area finished in this manner.

In any case, it should be borne in mind that a nicely graded and well kept landing ground is the very essence of a good and safe aerodrome, and money spent in achieving this result will, in the writer's opinion, give better return than that spent on expensive, oversize buildings—except, perhaps, in very exceptional cases. Buildings, if properly designed, can always be enlarged as conditions or increasing traffic demand.

Wind indicators.—One cannot stress too strongly that the various means of indicating the direction of the wind on an aerodrome should be more uniform in design. For example, illuminated landing tees should be of one definite pattern and fitted with a standard and universally approved method of illumination, whilst wind socks, as they are usually called, should be standard in size and colour, and not, as so often happens, just a collection of discoloured and raggy sky advertisements. Smoke wind indicators indicate more accurately the direction of the wind at ground or surface level.

Aerodrome Control.—This important branch of aerodrome organisation, which at present, unfortunately, is only in force at a few busy aerodromes, is now slowly being dealt with by the appropriate department of the Air Ministry, but it appears that it will take some considerable time to appoint and train the large number of control officers that are badly needed.

In the meantime, in the interests of safety, it appears to the writer that a simple form of control could be established by appointing a reasonably intelligent member of the traffic or tarmac staff to "flag" aircraft, particularly those carrying passengers, for the purpose of regulating their movements when landing and taking-off.

There is another thing a number of pilots would like to see, particularly at busy aerodromes: when a big airliner is due a distinguishing signal should be flown from the control tower, thus warning them that such an aircraft is in the air and to look out for it and, if necessary, to give it the right of way to land first.

Ground Marshalling

Ground control.—A clear and well ordered method of procedure in regulating the movements of aircraft after landing is important so that taxi-ing is brought to a minimum, with consequently less risk of baulking or fouling other aircraft; a well defined area for arrivals and departures is also very essential. In this respect the writer would like to suggest that matters would be much simplified if, instead of the rather common practice of someone trying to give the pilot his direction by frantically waving, an efficient member of the tarmac staff was appointed to attend to this particular function; and he might well be supplied, as is fairly common practice abroad, with a suitable flag or light metal disc on a wooden handle clearly marked with the letter "C," indicating Control; this should leave no doubt in the mind of the pilot where he is to park his aircraft or disemplane his passengers.

Medical and ambulance arrangements.—It is as well that the ambulance and fire-fighting vehicles should be housed facing the landing area, and some means provided during cold weather for keeping the engine warmed, ready for a quick get-away.

Another important point to remember is that a crash may occur just outside or away from an aerodrome; possibly much time will be saved if suitable gaps are left in the boundary fences for the crash tender to drive through; such gaps should be clearly marked. Mr. Payne, Manager of Southampton Airport, makes a good suggestion, namely, "Instead of using gates

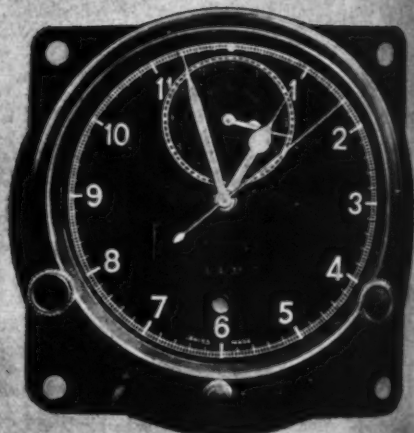
Covered gangways leading out to the tarmac at Tempelhof. The new Tempelhof—described in *Flight* last week—will allow whole airliners to load up under cover, and the new Elmdon (Birmingham) Airport will have "platform roofs."

* *A suggestion made more than once in "Flight."—Ed*

SARO "LONDONS" OVER GIBRALTAR returning to England on a non-stop flight upon the completion of co-operation exercises with the Fleet

Aircraft Clocks

Type V. 303
Mark II



Type V. 304
Mark IIIA

as supplied to

THE AIR MINISTRY

SMITH'S AIRCRAFT INSTRUMENTS

CRICKLEWOOD WORKS
LONDON · N.W.2

Quick and systematic handling of holiday passengers and joy-riders has been brought to a fine art by Portsmouth, Southsea and Isle of Wight Aviation. Their I.O.W. ferry has introduced thousands to flying.

the emergency gaps should be closed with light wooden slats, suitable vertical bumper bars being fitted on the front of the ambulance or crash tender to enable it to be driven straight through without stopping or damage to the vehicle."

There is no necessity to maintain a special crash crew or driver; a voluntary crew can be trained from aerodrome employees. In the case of Shoreham Airport these are chiefly the porters, a number of whom have been trained by the airport medical officer and hold St. John Ambulance certificates and are paid a small additional weekly wage as long as they hold such certificates.

Finally, for obvious reasons, it is as well to arrange that the position of the medical officer's room should be so situated that the ambulance can drive up with casualties without being under the direct eye of the public.

The next point to consider is that of making an aerodrome more attractive to the public.

To increase the general popularity of an aerodrome there is no doubt that by the provision of certain amenities and by more attention to the comfort of visitors, people can be induced to visit aerodromes in steadily growing numbers; money spent in these directions should, if properly applied, go at least some way towards increasing the business of the undertaking.

Aerodrome buildings.—For example, why should not these be designed on more attractive, colourful lines? But whilst on the subject beware of the rotunda type of building, which must of necessity be built on a rather grand and somewhat extravagant scale, as it cannot be easily added to or enlarged at a later date to meet growing needs.

Then what about a few bright flower boxes at the windows and on the terraces and, possibly, a line of white masts flying gaily coloured flags or the burgees of the various airline companies operating on the route?

Again, for the darker days or evenings, it is suggested that a certain amount of discreet neon lighting, if only to outline the name of the aerodrome, would give an air of warmth and cheerfulness.

The Inner Visitor

Catering.—Now let us turn for a moment to the catering side of the business. Here the writer has very definite views and has long preached the gospel that aerodrome catering should be run more on Continental lines. Unfortunately, for a variety of reasons, this ideal appears difficult to achieve. Nevertheless, when considering this very important matter, at least try to get your restaurant managed on modern roadhouse lines, with simple food decently cooked and daintily served, and not as a very third-rate hotel or station buffet. If waiters are employed let them be dressed steward-fashion, which is much more in keeping with the surroundings, where nothing looks more out of place than waiters in broken-down dress clothes.

The restaurant—which, incidentally, should be licensed—should face the flying ground and be capable of being opened out on to a covered terrace, with a railed-in space in front, and provided with plenty of metal tables surmounted by brightly coloured umbrellas, thus enabling people during fine weather to have their refreshments in comfort while watching the flying and other activities of the aerodrome.

Access to the restaurant should also be available to visitors in the public enclosure, to avoid the necessity of having to enter via the main traffic hall, which they are usually shy of doing, and in any case they may prove a nuisance to the staff during rush hours.

The ideal arrangement, of course, would be to have a separate café adjoining the public enclosure—which, incidentally, should face away from the sun.

Additional Attractions

Amenities such as a bathing pool, tennis and squash courts are also worthy of consideration, especially if the aerodrome is situated some distance away from similar forms of entertainment.

Joy flights.—Convenient facilities should be provided for visitors to take short pleasure flights, and arrangements should be made with one of the tenants at the aerodrome (or, failing them, the club) to deal with this side of the business.

Conducted tours over the aerodrome buildings, for which a nominal fee can be charged, are always popular, and can be carried out by a uniformed guide or one of the porters, provided he is of the right type. These tours are not only good propaganda, but revenue producing. Croydon, as you know, does big business in this direction, and at Shoreham we have found it more than worth while.

An idea which has been carried out at Frankfurt Airport with great success is the construction in the public enclosure of a large scale model of the control tower. A skilled demonstrator explains the interesting routine of this side of the work and the actual movements and wireless control of approaching and departing aircraft are reproduced by means of a loudspeaker and other devices. A nominal charge is made for admission to this aeronautical side-show, which has proved both popular and profitable.

Incidentally, if you decide to install a public address system at your aerodrome, don't overdo its announcements; while such broadcasting has its practical uses and is also of interest to the outside public, it can defeat its own ends by over-insistence in the form of "broadblasting."

Finally do not forget to provide ample free car parking facilities and, if means allow, a covered shelter or garage for the cars of passengers and staff.

* * *

Mr. Volk's paper concluded with detailed suggestions as to various methods of publicity that might be profitably employed by airports. He discussed the comparative value of various methods of advertising, ranging from "taking space" in newspapers to the employment of sandwich-board men in local towns. Mentioning aerial banner advertising, he was critical of the effect of the aircraft noise on the public which it was designed to interest.

"An efficient member of the tarmac staff . . . might well be supplied, as is the fairly common practice abroad, with a suitable flag or light metal disc on a wooden handle, clearly marked with the letter 'C,' indicating Control."

MAKING READY : Private-owner and other types inside the big service hangar at Heston. This hangar will, in due course, be taken over by British Airways and another service shop erected elsewhere.

PRIVATE FLYING

Topics of the Day

International

IF there is one good reason for the encouragement of what may be called independent flying, whether organised or not, it is that it promotes international good feeling.

That sounds suspiciously like the politely meaningless statement of a professional diplomat or one of the column-filling *clichés* of a dull leading article on international relations that has oozed from the pen of some self-appointed expert.

Nevertheless, there does not seem to be any doubt, generally speaking, of its truth. Anyone who has made the rounds of a few representative international flying meetings will understand quite well what I mean. Even apart from the plainly sportive affairs one has only to travel abroad among air transport people to find that flying and flying alone is the thing that really matters and a common interest automatically makes the difference between friendliness and animosity.

On one evening last week I spent a very large number of hours in the company of one of those whom we are pleased to call foreigners. During the period I listened to nothing but sound and benevolent common-sense. He was a man who travelled around amongst flying people a great deal in the course of his work, and he had practically nothing but kind things to say about the people of every nation in Europe.

On the following evening, I spent about the same number of minutes listening to malicious nonsense about some of these same foreigners from, I regret to say, the mouth of one of my own nationals—and a fairly important one at that. (For which reason his audience acted as yes-men though two of them at least should have been sufficiently independent to find no need to act as a pair of bellows.)

These, of course, are two very extreme cases, but in one the effect of a real and continuous enthusiasm for the whole business of flying was apparent and the probability is that when he travelled outside his own country he would discuss very little else and would certainly not attempt to criticise the opinions and habits of his different hosts.

Hospitality

WE in this country still owe a considerable debt to flying clubs and organisations abroad, since for every international flying meeting held over here there are half a dozen held on the Continent and elsewhere. At every one of these, visitors of all nationalities are treated so magnificently that they are almost embarrassed and I certainly feel uncomfortable when I think of the few affairs of the same kind which are organised over here. (Lympne, York and the R.Ae.C. week-end are the only British fixtures that come to mind; and Lympne, I believe, have had such an overwhelming success with theirs that they feel unable to undertake another with the facilities at their command.)

One can hardly blame the individual clubs and private owners, since, obviously by themselves and without assistance either from the governing body or from the Air Ministry, they cannot possibly afford to run such meetings. Nevertheless, it is rather odd that what is possibly the richest country in the world should be outshone by others, some of which are persistently accused in a general way of being inhabited by specially selected villains.

Possibly—indeed probably—the organisations abroad are quite effectively subsidised by their Governments, who feel very rightly that flying meetings and the like have a quite useful effect on international relations. Such a subsidy should be a good investment and our own Royal Aero Club might see what it can do on the same lines by a little judicious influence in the right quarters.

For some reason or other we have an unholy reputation abroad for being quite unable to co-operate about anything, and our own national air transport company is not exempted—at least so far as technical developments are concerned. We may, as a nation, have the nicest possible feelings about other people, but these are not really very much good unless they are shown as often as possible. For this reason I believe very firmly in the value of the international flying meeting idea; even if the effects seem to be small and sometimes quite local, they travel widely because the very people concerned are those who themselves move about more often and more rapidly than any other section of the community.

A friend of mine who likes to visualise himself as a sort of pacifist dictator always maintains that a Channel tunnel with motor road and railway (Government-subsidised free excursions to everywhere abroad) would set this suspicious world to rights. Well, we have the next best thing.

Descent

BY this time the general flying public must be getting a little tired of the tricycle undercarriage and its attendant advantages and disadvantages. However, last week, while flying a machine so equipped, I thought of one little trouble which might be experienced by a pilot who was endeavouring to do the shortest of short approaches and, at the same time, realised the possible advantages of a rate-of-descent indicator in the case of any machine which may safely be brought in at or near the stall in such circumstances.

The trouble concerns the possibility either of making a very late attempt to gather a little more speed or of actually flying so very slowly that the nose drops momentarily—thus, in either case, causing the nose wheel to take the entire brunt of the impact. Actually, the nose would have to be pushed down very steeply, but the possibility should be considered, now that such powerful flaps are fitted, by any designer who is going ahead with the tricycle arrangement.

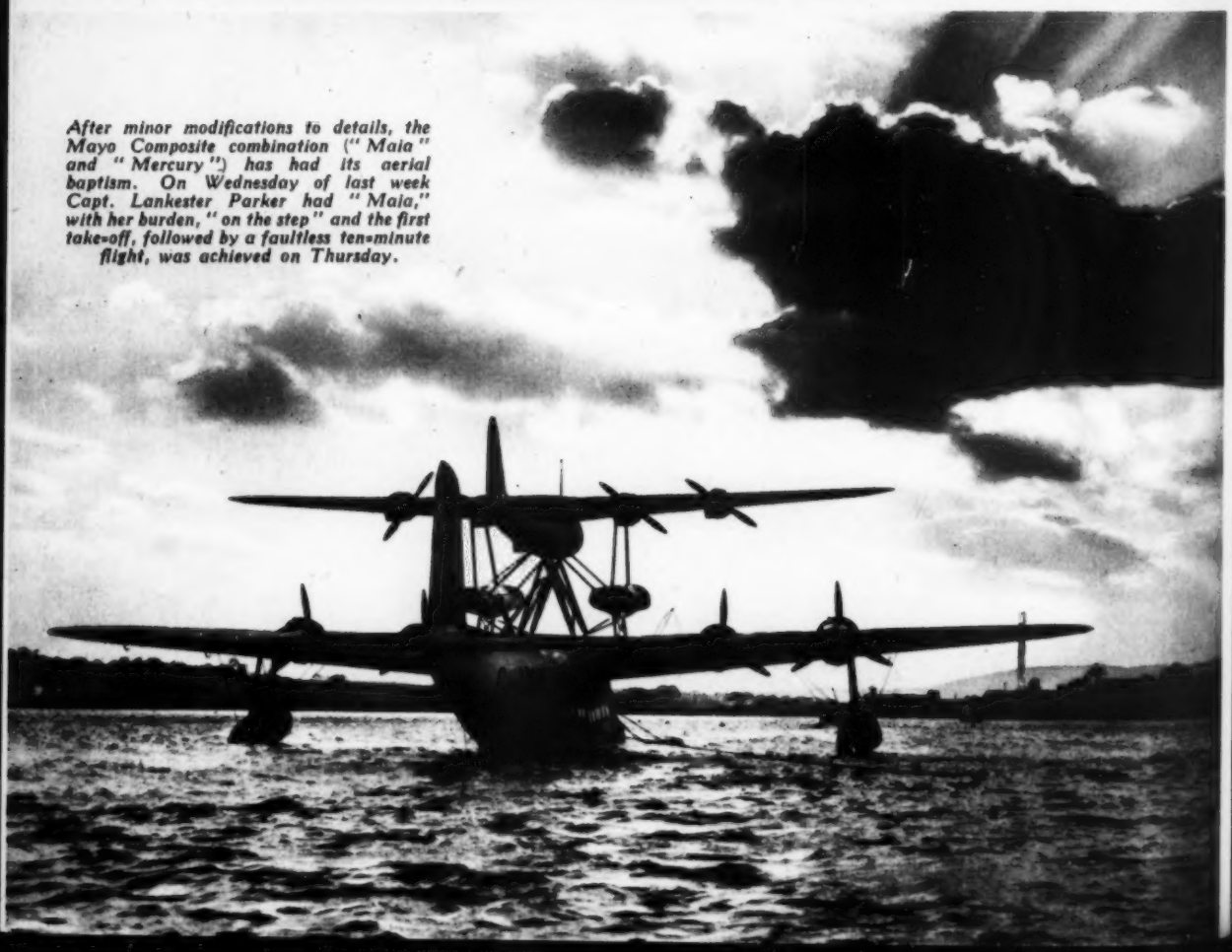
The utility of a rate-of-descent indicator is obvious. There is a limit to the blow which even the very best undercarriage will take without damage, and this limit may usually be gauged in feet per second. A rate-of-descent meter will give the necessary information with a reasonable degree of accuracy during a stalled or semi-stalled approach on a fool-proof aeroplane and may thus save expensive damage. As our aeroplanes become more like the balloons which they originally superseded, such assistance will be worth serious consideration and the instrument-makers may as well set about the business of producing reliable devices at a reasonable price. I am all for balloons.

INDICATOR.

THE DRONE OF HISPANOS

The eleven bridges of the Seine, the gardens of the Tuilleries, the Place de la Concorde are taken in at a glance by French bomber-pilots parading their Hispano-powered Potez 54's over the heart of Paris. The industrial areas (below) are aesthetically unattractive but abound in vulnerable targets.

A GREAT ADVENTURE



After minor modifications to details, the Mayo Composite combination ("Maia" and "Mercury") has had its aerial baptism. On Wednesday of last week Capt. Lankester Parker had "Maia," with her burden, "on the step" and the first take-off, followed by a faultless ten-minute flight, was achieved on Thursday.

FROM the CLUBS and SCHOOLS

LONDON

FLYING for the week ended January 22 totalled 45 hr 10 min., and new members included Messrs. C. B. G. McClure and G. Wong

BEDFORD

Although only recently formed, this club is making good headway. Two new flying members were Messrs. E. Clark and A. C. Kelway.

NORTHAMPTON

There are still a few tickets available for the annual dance in Northampton on Friday, January 28. Flying time has been well up to average.

READING

The dance held by the club recently was well supported by both members and visitors. The steadily increasing membership is very heartening.

MIDLAND

Several cross-country flights were carried out to Hatfield, Heston, Pershore and Filton and flying times totalled 29 hr. 45 min. Two new members were welcomed.

C.A.S.C.

Members of the Civil Aviation Service Corps flew a matter of 10 hours at Cambridge Aerodrome last week-end. A number of new members have started their preliminary ground instruction course.

NEWCASTLE

Approximately 160 guests attended the annual dinner-dance held at the Royal Station Hotel on Friday last. Flying was well up to average, 17 hours being spent in the air. Mr. J. Whittaker is a new flying member.

HAMPSHIRE

Flying for two days was completely held up owing to gales, but 43 hr. 55 min. was flown during the week. The twelfth annual dinner and dance will be held on Friday, February 25, at the South Western Hotel, Southampton Mr. E. P. Swallow has qualified for an "A" licence and Mr. C. Bayley has joined the club.

YORKSHIRE

In spite of the unpropitious weather members spent 36 hours in the air. A number of trips were undertaken for the Press in order to take pictures of the extensive flooding. The Auxiliary Air Force is now firmly rooted and is replacing its temporary quarters and hangars with permanent buildings.

NORFOLK AND NORWICH

The development of the gliding section is going ahead rapidly and a Ford V8 towing-car has been purchased. In the power section nearly 30 hours' flying was put in and the testing for the scholarship scheme has nearly been completed. The members of the Strangers' Club have been invited over for an informal evening.

HANWORTH

A landing competition at Aldenham aerodrome will be held on Sunday, February 20 The dance has been postponed to Friday, February 18. New members include Messrs. B. C. Middleton and Wise, and Mr. Moore, of the Air League of the British Empire, made a first solo. A total of 43 hr. 5 min. represented the week's flying.

STRATHTAY

High winds, snow and rainstorms have rather cramped flying for the last two weeks, and up till January 15 only 17½ hours were spent in the air during the month. However, the membership still continues to increase.

MARSHALL'S

A total of 50 hr. 25 min. was put in at Marshall's flying school during the week ended January 22. On Friday a party of flying visitors from the Cinque Ports Club were entertained. While they were at Cambridge they were taken round the city. Three new members have been enrolled.

PORTSMOUTH

The scheme for providing an "A" licence at an inclusive fee of £25 is attracting a great deal of attention; there are 28 prospective pupils, several of whom are starting instruction. The monthly dance held on January 5 was quite a success, and the bridge drive held on January 19 was another feather in the entertainment committee's cap.

SOUTH COAST

The Gorringe Trophy Competition was due to start last Sunday and takes the form of a cross-country handicap. Each competitor will be accompanied by Mr. Pashley and points will be awarded on the competitors' decision as to weather conditions, taxying into position, take-off, course-keeping and turning on to new course, and landing. Unlicensed competitors will be excused the first two items and will be awarded full points for them. The experience of the competitors will also be taken into account. The first meeting of the new committee will be held next week. Flying has been considerably handicapped by the weather.

BROOKLANDS

A very active report comes from Brooklands Flying Club, this showing a total of 70 hr. 20 min. flying for last Sunday alone, and an increase of eighteen new members. The annual general meeting was held at the clubhouse on Saturday last, when Major F. C. Atkinson took the chair. Suggestions for improvements in the variety of items of interest over the week-ends took the form of a dramatic committee. Previous to the meeting a club dinner had been held and the evening concluded with dancing in the clubhouse. Five machines from the Cinque Ports Flying Club landed at the aerodrome and their pilots stayed the night A novel handicap for the new series of competitions is that members who have flown over ten hours' solo will be "discredited" with half a mark for every hour above that total, with a maximum handicap of 40 marks.

CINQUE PORTS

Four club machines accompanied by four privately owned machines started on Friday, January 21, on a short cruise of the South of England, including stops at Cambridge, Oxford, Birmingham, Cardiff, Eastleigh and Brooklands. Everything went to schedule as far as Oxford, but the weather compelled them to stay an extra night there. They went straight on to Eastleigh the next day, cutting out Birmingham and Cardiff, but Sunday night found them at Brooklands as arranged. The annual dinner and dance will be held on March 11 at the Grand Hotel, Folkestone. Special facilities are being made for those wishing to stay the night. Mr. and Mrs. Davis will be away until February on a well-earned holiday in Madeira. Mr Halford made a first solo and Messrs. R. A. K. Roberts, A. L. Bagshawe and D. Currey have successfully passed their "A" licence tests. Flying totalled 41 hours during the week ended January 23.

Johannesburg Return

THOSE club members and others who met the South African crew of the Junkers Junior in England last summer will be pleased to learn that Mr. Philip Hasselson has safely returned to Baragwanath aerodrome. Apparently the Junkers gave no trouble and the journey was, in fact, uneventful.

A Hanworth Engagement

VISITORS and residents at the Hanworth Park Hotel, and particularly those who have been connected with Hanworth aerodrome during its vicissitudes of the last few years, will be both glad and sorry to learn of the engagement of Miss Madeleine Cournède and Mr. Gerald Farquharson. As one who has so well looked after the hotel and its residents, Miss Cournède will certainly be missed. Mr. Farquharson is Mr. Malcolm's partner in the aircraft agency of that combined name.

A Year of A.S.T.

APART from a fleet increase which brings up Air Service Training's Hamble equipment to 53 basic trainers, 4 multi-engined machines for specialised training, and 5 flying boats, there has been considerable development in the accommodation arrangements during the past year. A new administrative block has been built, a meteorological office has been installed, lecture-room accommodation has been augmented, and the size of the main hangar has been doubled. In addition a new mess will be opened early in February, and a considerable amount of land has been purchased for aerodrome enlargements.

During 1937, 151 students, including 44 Imperial Airways pilots, passed through the school, and at the end of the year 42 pupils were going through the three-year commercial pilots' course. Extensive instructional tours—a new feature—have been made on the Continent.

In order that transport training might be more complete, Adcock short-wave D/F equipment is now being installed, and Lorenz blind-approach transmitters should be in operation quite shortly. The machine to be used for such advanced training is being fitted with two-way radio and D/F equipment, and, of course, with blind-approach receivers.

Needless to say, Air Ministry contracts in the matter of reserve training have kept the school busy.

Going Abroad

YET another Foreign Air Regulations Handbook has been added to the nine which have already been issued by the Air Ministry. This particular one covers Jugoslavia and gives, as usual, all the necessary information concerning customs and similar formalities, corridors, prohibited areas (with maps), and general regulations.

Incidentally, a new handbook will shortly be issued for Austria, since the original one has, during the past few months, been very severely modified on practically every page. No more amendments will be published for the latter.

SERVICE AVIATION

End of the Hendon Display

THE Royal Air Force Display has lately been under consideration by the Air Council, and it has been decided to discontinue it.

The display was first held in 1920, and has been held annually since that year. The primary and main object of its original institution was to provide a culminating point for the training of squadrons stationed in this country. In addition it was desired to show the public something of the work and progress of the R.A.F.

A large part of the attraction of the display has been the presentation of intricate evolutions in a comparatively confined space within clear view of all the spectators. The advent of new aircraft of greatly increased power and speed has led to the development of new technique in training and tactics. If, therefore, the display was to maintain a real connection with the Service training of the Air Force, its character would have to be radically altered. The aircraft taking part would need to manœuvre over a much wider area, and its attractiveness to the spectators would thus be greatly diminished. For these and other reasons, Hendon is obviously unsuitable.

The number of Service aerodromes has greatly increased, and these aerodromes have become much more accessible. These changed conditions led to the establishment, in 1934, of an annual Empire Air Day, when large numbers of aerodromes are thrown open to the public, and the attendance last year was approximately twice the number of spectators at the display. The Air Council intends to extend the scope of this day.

Flying Accidents

THE Air Ministry regrets to announce the following accidents:—Sergt. Geoffrey Edwin Gaskell lost his life and P/O. Roland Robert Stanford Tuck was slightly injured as the result of a collision in the air which occurred near Uckfield, Sussex, on January 17, between two single-seater aircraft of No. 65 (Fighter) Squadron, Hornchurch, Essex.

A/C.2 Walter George Goodhand lost his life at Upper Heyford on January 17, as the result of falling from an aircraft of No. 57 (Bomber) Squadron, Upper Heyford, Oxford. A/C.2 Goodhand was a passenger in the aircraft, the pilot of which was not injured.

Lt. John Charles Hugh Price, Royal Navy, Flight Lieutenant, Royal Air Force, and Able Seaman Leslie V. Hammond, Royal Navy, lost their lives in an accident which occurred near Somerset West Cape, South Africa, on January 20, to an aircraft of No. 716 (Catapult) Flight, 6th Cruiser Squadron, South Africa.

P/O. Leonard Rene Helps, Brian William Grieves, and Theodore Quentin Smith, lost their lives as the result of a collision in the air, which occurred near Hatfield on January 21, between an aircraft of No. 66 (Fighter) Squadron, Duxford, and an aircraft of No. 1 Elementary and Reserve Flying Training School, Hatfield. P/O. Helps was the pilot of the former aircraft. Mr. Smith (Instructor) was the pilot of the other aircraft, and Mr. Grieves, a pupil under training for the Royal Air Force, was a passenger in the machine.

Royal Air Force Gazette

General Duties Branch

Group Capt. N. C. Spratt, O.B.E., is placed on the retired list (January 15).

Medical Branch

Flt. Lt. A. H. Osmond, M.R.C.S., L.R.C.P., is transferred to the Reserve Class D (January 16).

Legal Branch

Flight Lieutenant on probation A. G. C. Somerhough is confirmed in his appointment (December 12, 1937). Flt. Lt. H. H. M. Shurlock relinquishes the acting rank of Squadron Leader (unpaid) with effect from March 8, 1937, on ceasing to act for the Deputy Judge Advocate General, Middle East. (Substituted for notification in *Gazette* of November 30, 1937.)

Princess Mary's Royal Air Force Nursing Service

Matron Miss E. M. Blair is appointed Matron-in-Chief (January 16); Miss K. C. Watt, C.B.E., R.R.C., relinquishes the appointment of Matron-in-Chief, and is placed on the retired list at her own request (January 16); Senior Sister Miss C. Walker, A.R.R.C., is promoted to the rank of Matron (January 16); Sister Miss M. E. Garnett is promoted to the rank of Senior Sister (January 16).

Royal Air Force Reserve

Reserve of Air Force Officers

General Duties Branch

The following Flying Officers are promoted to the rank of Flight Lieutenant (January 7):—S. R. Sherman, G. P. Longfield, E. Elgey. The following is transferred from Class A to Class C on the date stated:—Flt. Lt. C. R. J. Hawkins (October 12, 1937).

Royal Air Force Volunteer Reserve

Medical Branch

G. L. M. McElligott, M.R.C.S., L.R.C.P., is granted a commission as Squadron Leader with effect from January 18.

Auxiliary Air Force

General Duties Branch

No. 602 (CITY OF GLASGOW) (BOMBER) SQUADRON.—F/O. G. C. Pinkerton is promoted to the rank of Flight Lieutenant (January 8).

Royal Air Force Appointments

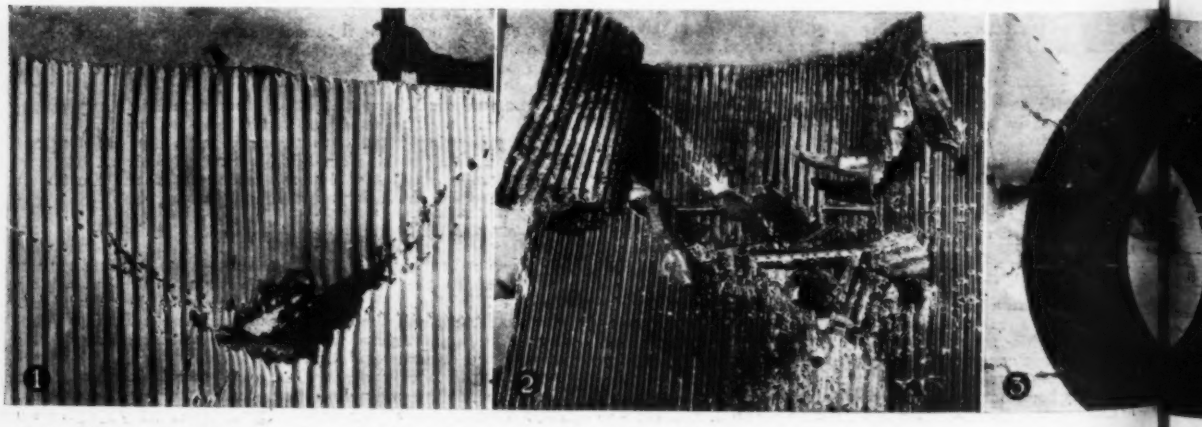
General Duties Branch

Group Captain.—A. H. Orlebar, A.F.C., to R.A.F. Station, Northolt; to command, 3.1.38.

Wing Commanders.—A. L. Fiddament, D.F.C., to Directorate of Intelligence, Air Ministry, 1.1.38. A. L. Paxton, D.F.C., to Directorate of Training, Air Ministry, 29.12.37.

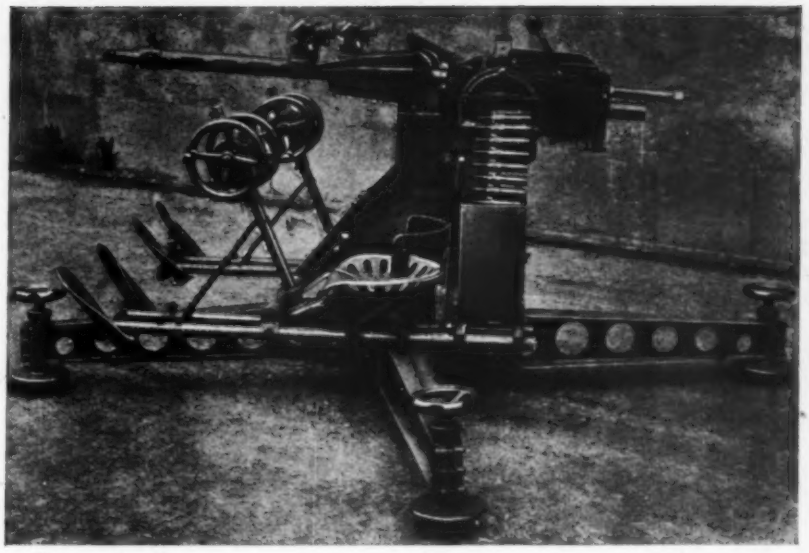
Squadron Leaders.—J. R. Addams, A.F.C., to Directorate of Technical Development, Air Ministry, 1.1.38. J. W. Colquhoun, to H.Q., Bomber Command, Uxbridge; for Air Staff (Intelligence) duties, 1.1.38. L. Dalton-Morris, to H.Q., No. 2 (B.) Group, Andover; for Air Staff (Intelligence) duties, 1.1.38. F. S. Hodder, to H.Q., No. 1 (B.) Group, Abingdon; for Air Staff (Intelligence) duties, 1.1.38. T. N. McEvoy, to Directorate of Intelligence, Air Ministry, 1.1.38. M. D. Ommanney, to H.Q., No. 4 (Bomber) Group, Linton-upon-Ouse; for Air Staff (Intelligence) duties, 1.1.38. A. C. H. Sharp, to H.Q., Bomber Command, Uxbridge; for Air Staff (Plans) duties, 1.1.38. A. T. K. Shipwright, D.F.C., to R.A.F. Station, Cranwell; for Administrative duties, 29.12.37. G. H. Stainforth, A.F.C., to No. 30 (B.) Squadron, Dhibban, Iraq; to command, 25.8.37. C. E. St. J. Beamish, to H.Q., No. 25 (Armament) Group, Eastchurch; for Air Staff (Armament) duties, 4.1.38. J. G. Franks, to H.Q. (No. 25) (Armament) Group, Eastchurch; for Air Staff (Armament) duties, 4.1.38. J. C. C. Slater, to H.Q., No. 16 (Reconnaissance) Group, Lee-on-the-Solent; for Air Staff (Armament) duties, 4.1.38. F. W. H. Hall, to No. 2 Armament Training Camp, Aldergrove; for Armament duties, 21.12.37. A. M. N. David, to No. 5 Armament Training Camp, Penrhos; for Armament duties, 21.12.37.

Flight Lieutenants.—R. G. Shaw, to R.A.F. Station, Gosport,



THE TARGET: Some destructive effects of the Madsen gun. From left to right: (1) Point of entry of 23mm. shell on Junkers metal

Royal Air Force and Official Announcements : Fleet Air Arm News : Military Aviation Abroad



THE GUN : The 23 mm. Madsen gun on A.A. mounting. This weapon is basically similar to the shell-gun now being specified for a number of advanced military aircraft. Some effects of this Danish weapon are illustrated below.

28.11.37. H. D. U. Denison, to No. 504 (County of Nottingham) (B.) Squadron, Hucknall, 3.1.38. R. Faville, to R.A.F. Station, Donibristle, 29.12.37. F. C. de la P. Beresford-Peirse, to School of Naval Co-operation, Ford, 4.1.38. W. J. F. Bull, to No. 1 Air Armament School, Eastchurch, 4.1.38. R. B. Dashper, to Marine Aircraft Experimental Establishment, Felixstowe, 4.1.38. R. H. E. Emson, to Aeroplane and Armament Experimental Establishment, Martlesham Heath, 4.1.38. J. O. Hinks, to Royal Aircraft Establishment, South Farnborough, 21.12.37. W. G. Bannister, to R.A.F. Station, Gosport, 21.12.37. E. F. E. Barnard, to No. 11 F.T.S., Wittering, 21.12.37. W. N. Elwy-Jones, to R.A.F. Station, Boscombe Down, 21.12.37. A. H. Jarand, to No. 2 Armament Training Camp, Aldergrove, 21.12.37. A. J. Kennedy, to No. 2 F.T.S., Brize Norton, 21.12.37. R. A. E. Traill, to No. 6 Armament Training Camp, Woodsford, 21.12.37. I. H. D. Walker, to No. 8 F.T.S., Montrose, 21.12.37. D. E. B. Wheeler, to No. 3 Armament Training Camp, Sutton Bridge, 21.12.37. C. H. Brandon, to No. 8 Armament Training Camp, Evanton, 21.12.37. C. L. Dann, to Aeroplane and Armament Experimental Establishment, Martlesham Heath, 21.12.37. C. J. P. Flood, to No. 6 F.T.S., Netheravon, 21.12.37. K. Gray, to R.A.F. Station, Halton, 21.12.37. E. C. Harding, to R.A.F. Station, Mildenhall, 21.12.37. H. R. Tidd, to R.A.F. Station, Andover, 21.12.37. G. A. Walker and J. D. Nelson, to No. 1 Armament Training Camp, Catfoss, 21.12.37. R. G. Prier, to Armament Training Camp, North Coates, 21.12.37.

Equipment Branch

Flight Lieutenants.—F. C. Read and W. G. S. Wood, to Directorate of Equipment, Air Ministry, 1.1.38. C. S. Whellock, to No. 11 Equipment Depot, Chilmark, 3.1.38.

Accountant Branch

Squadron Leader.—F. W. Arthurton, to No. 1 Air Armament School, Eastchurch; for Accountant duties, 28.12.37.

Flight Lieutenant.—L. Chegwidden, to R.A.F. Station, Linton-upon-Ouse, 6.1.38.

Medical Branch

Flight Lieutenant.—A. W. Smith, to R.A.F. Station, Turnhouse, 1.1.38.

Owing to the greatly increased length of these lists as a result of R.A.F. expansion, ranks are confined to those of Flight Lieutenant and above.

FOREIGN SERVICE NEWS

"Le Faucheur" High Dives

FOKKER'S surprise at the last Paris Show—the G.1 fighter-attack twin-hulled monoplane, *Le Faucheur*—has recently been tested by an officer of the Finnish Air Force. At an all-up weight of 8,800lb. take-off was effected in from 270-440yd.

According to reports, the diving qualities were found good; diving from 10,000ft. the machine reached 385 m.p.h. and came out easily, although the nose fairing of the central nacelle, which carries the crew and armament, caved in under the pressure.

The landing speed is reported to be 75 m.p.h. (presumably at full load), with a run similar to the take-off.

Capt. Magnusson, who conducted the tests, likened the flying qualities to those of a fine single-seater fighter. A three-seater version with Bristol engines (Mercury or Perseus) is being built.

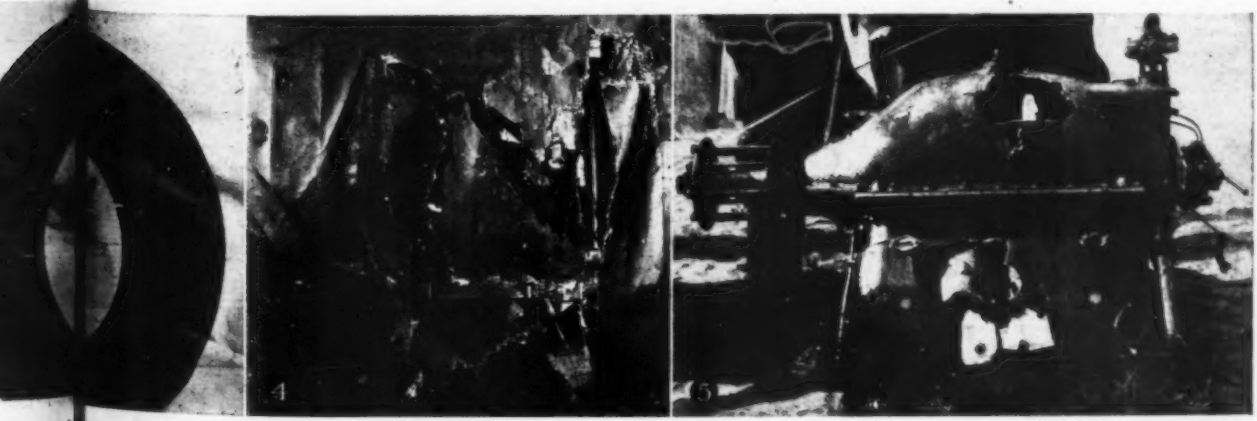
A Modern Service Transport

DETAILS were recently announced of a new Lockheed military transport monoplane developed for a U.S. Army Air Corps competition which may result in a contract for a maximum of 100.

An adaptation of the standard Lockheed 14 civil transport, the machine is planned specifically for the carriage of supplies and stores and is not intended to function in an emergency as a bomber as is our Bristol Bombay; a specialised bomber version is available.

Fitted with two Pratt and Whitney Hornets, the new Lockheed is capable of 250 m.p.h. Cruising speed is 227 m.p.h., and a non-stop range of over 2,000 miles is available. If required the machine may be used as an ambulance or as an eleven-passenger transport.

Stowage is provided for three radial engines of 1,000 h.p., the storage space available being 580 cubic feet.



...xit from same wing ; (3) entry of similar shell on fabric wing : (4) exit from fabric wing ; (5) damage to crankcase of ancient Hispano engine.

HERE and THERE

Reviving the "Landing Stick"?

RECENTLY *Flight* had occasion to recall the experiments with a "landing stick" at Farnborough. It now appears likely that the idea will be revived in improved form, and when certain patent questions have been settled we hope to give particulars of the new device. It is designed to flatten out the aircraft automatically at any desired predetermined height above the ground or sea.

Return to the Fold

MR. H. RICHARDSON, after an absence of several years, has again joined up with his old firm, Armstrong Siddeley Motors, Ltd. For a period he was on the technical staff of Wolseley Aero Engines and afterwards joined the Austin company in connection with the shadow scheme. Mr. Richardson has now taken over the post of development engineer at the Siddeley works.

Bristol Mercury Handbook

THE handbook of the Bristol Mercury air-cooled, radial engine has been published as a fellow to the Pegasus handbook. It contains complete details of the Mercury VII, VIII and IX engines, together with instructions of installation, running, maintenance, overhaul and testing.

The circulation of the handbook, compiled by the Bristol Aeroplane Co., Ltd., of Filton, Bristol, is limited to those who have dealings with Mercury engines.

A Heinkel Change

THAT a firm starts as a private company, and later, when it has grown to some size, becomes a limited company, is not unusual. The reverse procedure is less common, but it does happen, at least in Germany.

On January 10, Dr. Ernst Heinkel took over, lock, stock and barrel, Ernst Heinkel Flugzeugwerke G.m.b.H., of Seestadt Rostock. The only external change in the title of the company will be the disappearance of the letters G.m.b.H., which correspond to Ltd. Associated with Dr. Heinkel remain the following directors: Franz Klebe, Hermann Ritter von Pfistermeister, Karl Hayn, Dr.-Ing. Heinrich Hertel (Technical) and Dr.-Ing. Dietrich Rühl.

Dr. Heinkel is one of the oldest German aircraft designers and constructors, and his products have won approval and admiration all over the world.

Ten Thousand Pilots a Year?

SUPPORTING his contention that it was possible to train fifty thousand pilots in five years, Mr. W. R. Chown, the President of the Northern Aviation School and managing director of F. Hills and Sons, claims that the Volunteer Reserve scheme is inadequate and that the clubs are not being utilised to their best advantage. Last week Mr. Chown explained his ideas to a group of interested persons and was fairly severely cross-questioned.

His scheme is designed to make the best use of present club facilities, and he suggested that £25 should be paid by the Air Ministry every year for each pilot (the "A" licence being the sign of efficiency) to put in a matter of fifty hours. There would, of course, be no subsidy limit. The cost to the Government would be approximately £250,000 every year. Even on the most mass-produced basis we doubt whether it would be possible for a club to make ends meet on these figures, but Mr. Chown is evidently thinking in terms of the cost of training on very light and inexpensive machines such as are used at his own school.

However, Mr. Chown suggests that under his scheme an instructor's retainer might be reduced to about £2 a week and that the bonus on the extra flying would make up for this loss and result in a saving for the club. All we can say to that is we are sorry for the instructors, who will have to work very much harder to earn their present salaries. At the moment the fact that the very hard-working days are few and far between probably saves instructors from disruption. In any case, it is doubtful whether the English climate would permit an increase of flying to the extent visualised by Mr. Chown.

He has approached leading Manchester firms who have, it appears, agreed to permit employees of good health and intelligence to take a matter of one or two working hours off every week, these hours to be utilised in flying training. In this connection there is one considerable difficulty. Most employees have their life insurance arrangements and these are automatically nullified where flying is concerned. Mr. Chown suggested that special arrangements would have to be made.

The entire scheme is intended to provide bomber-pilots only. These, apparently, have only to fly straight there and back, and no knowledge of tactics, gunnery and so forth is considered necessary. Even if a sufficiently courageous crew could be found to fly with every one of Mr. Chown's thousands of pilots, it is doubtful if fifty or a hundred hours' flying in light aeroplanes can be considered as sufficient training for taking really large machines into the air, let alone getting them through over very long distances in all kinds of weather. Courses of training in instrument flying and in the handling of modern machines, with all their gadgetry in the form of v.p. airscrews, retractable undercarriages and flaps, would at least be necessary before these youngsters could even hope to start for a place 200 miles distant. Mr. Chown quite sensibly suggested film instruction in instrument flying and such subjects.

However, when allowance has been made for all the defects in detail considerations, the idea, in general, has something to recommend it if only as a method of encouraging a really large number of people into the air and, consequently, over what we might call the "first hurdle" in training for military service.

Last Week's Special Number of "Flight"

CONSIDERABLE space is devoted in this issue to the subject of airport organisation and operation, as discussed at the Airports Conference.

For the benefit of any readers who may have missed last week's issue of *Flight*, it may be said that it was a greatly enlarged special number published at the time of the Conference and dealing with the subject of Airports and the Equipment on very comprehensive lines.

Contents included a specially illustrated review of the latest airports, with ground plans; an explanation of modern air traffic control methods, with a map of the administration system; the future of aircraft radio; tendencies in airport design; and a review of current aerodrome equipment.

Copies of this special issue can be obtained at 7d. (postage included) from the publisher, Dorset House, Stamford Street, London, S.E.1.

South Atlantic Formation Flight

THE three Savoia-Marchetti S.79 bombers which set out from Guidonia, near Rome, at 6.30 a.m. last Monday on a three-stage flight to Brazil landed at Dakar (Senegal) at 5.10 p.m. the same day, having flown 2,800 miles non-stop at an average speed of over 260 m.p.h. and a height of between 13,000ft. and 16,000ft.

Lt. Bruno Mussolini, second son of the Duce, was piloting one of the three machines, each of which had a crew of five. The other two chief pilots were Lt.-Col. Biseo and Capt. Moscatelli.

The three-engined Savoias are similar to those which won the Damascus race; at least one is a machine which actually formed a unit of that team. The engines are Pegasus, built in Italy under licence.

To-night's R.Ae.S. Discussion

THIS evening an important R.Ae.S. discussion will take place on "High Wing Loading and the Three-wheeled Undercarriage." It is a continuation of the papers by Mr. H. F. Vessey, A.F.R.Ae.S., on "The Take-Off Problem in Modern Aircraft Design," and Sqn. Ldr. H. P. Fraser, A.F.C., A.F.R.Ae.S., on "High Wing Loading and some of its Problems from the Pilot's Point of View," and has been arranged at the request of many who wish the present situation to be thoroughly discussed. The discussion will begin at 6.30 p.m. and a large number of speakers have promised to take part.

The meeting will be held in the Lecture Theatre of the Institution of Mechanical Engineers, Storey's Gate, S.W.1. Non-Members will be admitted by ticket obtainable only through a member.

Airco's Address

TO remove any misconception which a recent note may have caused, it should be made clear that Capt. Rex Stocken and Airco, Ltd., aeronautical agents, are now at Eagle House, 109, Jermyn Street, London, S.W.1. (Whitehall 8863.)

January 27, 1938. Supplement to FLIGHT 96a

The AIRCRAFT ENGINEER

"FLIGHT" ENGINEERING SECTION

No. 144. (Volume XVI No. 1) 13th Year January 27, 1938

AEROFOIL PROFILE DRAG

Some Notes on Its Estimation, Based on Recent American Tests at High Reynolds Number

By W. R. ANDREWS, A.F.R.Ae.S.

IN a previous article on the subject of profile drag estimation (Ref. 1) the present writer outlined an empirical method based on part of the wind tunnel test data obtained by the N.A.C.A. in connection with their investigation into the characteristics of 78 related aerofoils (Ref. 2). These tests were carried out in their V.D. Tunnel at a Reynolds Number in excess of 3 millions. Since that date the N.A.C.A. have investigated the effect, on the aerofoil characteristics, of variations in Reynolds Number up to 8 millions (Ref. 3). The characteristics of the aerofoils can be divided into two main groups, first those which are not materially affected by scale—the zero-lift angle, the slope of the lift curve, the zero-lift moment and the aerodynamic centre. Secondly, those which are affected by scale—the maximum lift and the profile drag. This article is only concerned with variations of the latter with respect to the effect of Reynolds Number and changes in camber.

As in the previous work, the profile drag is considered in comparison with the drag of the symmetrical section of the same thickness-ratio. For ease of reference the summary of the test data at a Reynolds Number of 8×10^6 is given in a table. This table only includes aerofoils of normal camber without flaps.

The minimum drag of the symmetrical sections is shown in Fig. 1. Within the range of the tests the profile drag can be expressed as

$$C_{D_0} = 0.00605 + 0.74\, t^{2.85} \quad \text{when } RN = 8 \times 10^6 \qquad (1)$$

The minimum drag at any other Reynolds Number is found by means of the conversion factor suggested by the N.A.C.A. This is plotted in Fig. 2, from which the multiplying factor for obtaining the drag may be read directly.

When extrapolated to $t = .21$ equation 1 seems to overestimate the drag slightly. The calculated value is .0104, whereas section 23021 has a minimum drag of only .0101.

The N.A.C.A. found from their previous tests at the lower Reynolds Number that the minimum drag of the symmetrical sections could be expressed as

$$C_{D_0}\text{min} = .0065 + .0043t + .0972t^2 \qquad (2)$$

The new tests indicated that at $RN = 8 \times 10^6$ the drag of the symmetrical sections is only 83.1 per cent. of that given by 2. This indicates a minimum drag of only .0097 for the 21 per cent. thick aerofoil, showing that section 23021 has a drag .0004 greater than the .21*c* symmetrical section. This seems reasonable, so that for an alternative expression for the drag of symmetrical aerofoils at $RN = 8 \times 10^6$ we may write

$$C_{D_0}\text{min} = .0054 + .00357t + .0806t^2 \qquad (3)$$

As the camber of the section increases, the minimum drag also increases; this was previously at $RN = 3 \times 10^6$ averaged and expressed as

$$\triangle_1 C_{D_0} = 0.33\,\gamma^2 \qquad (4)$$

Where γ = max. camber ÷ chord ratio.

By inspection this expression does not hold for the results obtained at $RN = 8 \times 10^6$.

An interesting relationship is indicated by plotting the increase in drag, due to camber, against the zero-lift moment (C_{M_0}) as in Fig. 3. Since the zero-lift moment and the increase in drag due to camber are both functions of the camberline shape, it is not unreasonable to assume that some relationship exists between them. Fig. 3 clearly indicates this; it also shows that the points fall into two groups, one for the aerofoils having the camberline in the form of two parabolic arcs, and the other for aerofoils having the forward part of the camberline of parabolic shape and the rear portion a straight line. (These last ones are the 23012–43012 sections at the bottom of the table, and are referred to as the 230 series.) These relationships are interesting, especially as they suggest that the minimum drag of the 230 series is higher than that of the other series at the same zero-lift moment. It must be remembered, however, that for the same camber the zero-lift moment of the 230 series is considerably smaller than for any other section listed.

It was demonstrated previously that the value of C_L at which the profile drag is a minimum (designated as $C_{L_{OPT}}$) varied with the type of centreline. This method is cumbersome in operation, and the resulting accuracy is unjustified. In order to arrive at a more general relationship, $C_{L_{OPT}}/\gamma$ for 12 per cent. thickness aerofoils has been

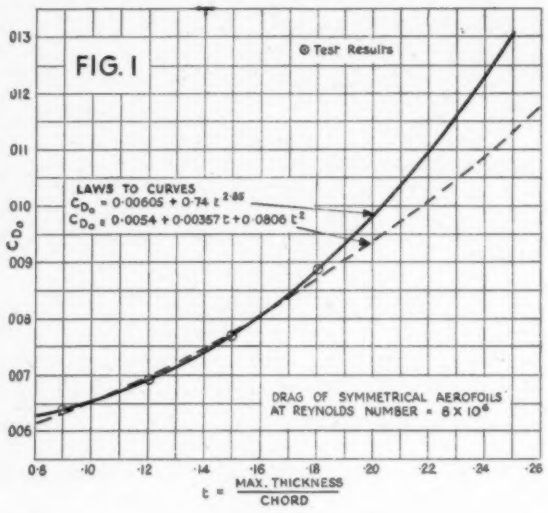


FIG. 1
⊙ Test Results
LAWS TO CURVES
$C_{D_0} = 0.00605 + 0.74\ t^{2.85}$
$C_{D_0} = 0.0054 + 0.00357\ t + 0.0806\ t^2$
DRAG OF SYMMETRICAL AEROFOILS AT REYNOLDS NUMBER = 8×10^6
C_{D_0}
$t = \frac{\text{MAX. THICKNESS}}{\text{CHORD}}$

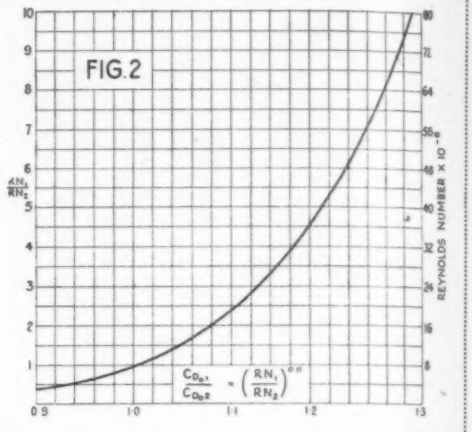


FIG. 2
$\frac{C_{D_{0_1}}}{C_{D_{0_2}}} = \left(\frac{RN_1}{RN_2}\right)^{0.11}$
REYNOLDS NUMBER × 10⁻⁶

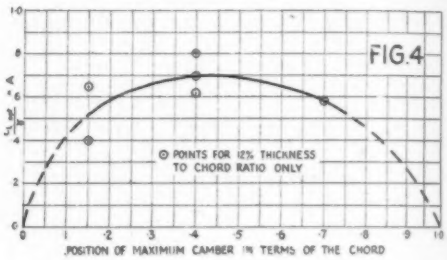


FIG. 4
⊙ POINTS FOR 12% THICKNESS TO CHORD RATIO ONLY
POSITION OF MAXIMUM CAMBER IN TERMS OF THE CHORD

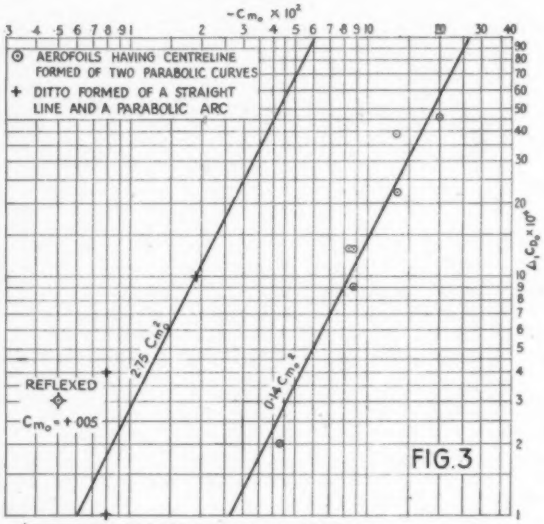


FIG. 3
⊙ AEROFOILS HAVING CENTRELINE FORMED OF TWO PARABOLIC CURVES
+ DITTO FORMED OF A STRAIGHT LINE AND A PARABOLIC ARC
REFLEXED
$C_{m_0} = +.005$
$2.75\ C_{m_0}^2$
$0.14\ C_{m_0}^2$
$-C_{m_0} \times 10^2$
$\Delta_1 C_{D_0} \times 10^4$

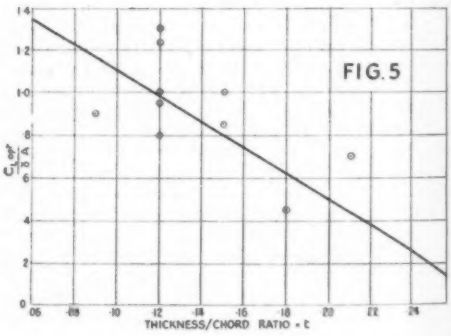


FIG. 5
THICKNESS/CHORD RATIO = t

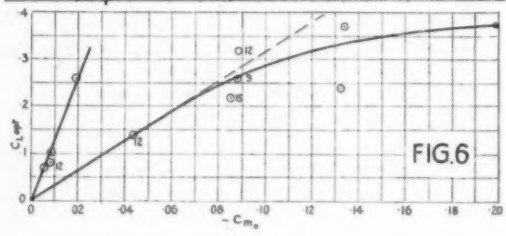


FIG. 6
$C_{L\,opt}$
$-C_{m_0}$

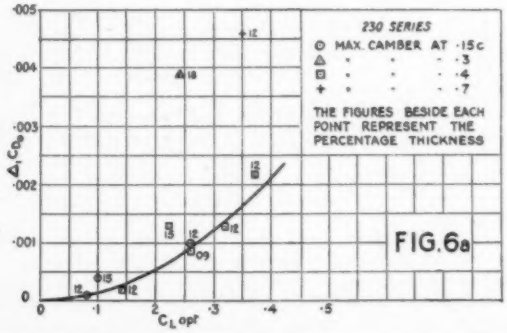


FIG. 6a
230 SERIES
⊙ MAX. CAMBER AT .15c
△ " " " .3
□ " " " .4
+ " " " .7
THE FIGURES BESIDE EACH POINT REPRESENT THE PERCENTAGE THICKNESS
$\Delta_1 C_{D_0}$
$C_{L\,opt}$

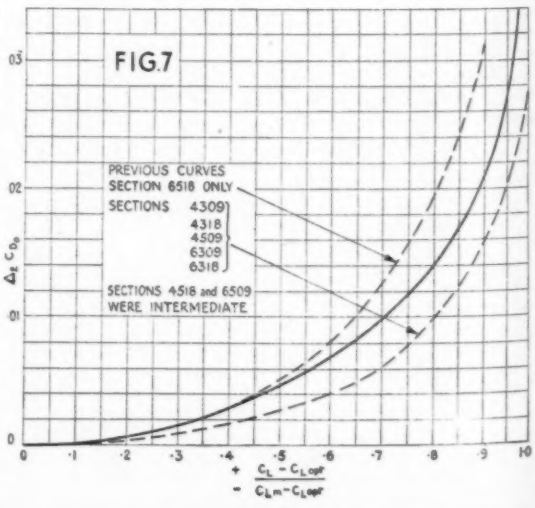


FIG. 7
PREVIOUS CURVES
SECTION 6518 ONLY
SECTIONS 4309
4318
4509
6309
6318
SECTIONS 4518 and 6509 WERE INTERMEDIATE
$\Delta_2 C_{D_0}$
$+ \frac{C_L - C_{L\,opt}}{C_{Lm} - C_{L\,opt}}$

plotted against the position of maximum camber in Fig. 4. This graph suggests that for a given camber $C_{L_{OPT}}$ is greatest when the maximum camber occurs at .4*c*. The mean curve drawn through the points of Fig. 4 has been used to calculate those of Fig. 5, on the assumption that this curve applies in form to all thickness ratios. The final relationship for $C_{L_{OPT}}$ by this method is

$$C_{L_{OPT}} = (1.7 - 6t)\,\gamma A \quad .. \quad .. \quad (5)$$

where t = maximum thickness in terms of the chord length

γ = maximum camber in terms of the chord length

A = constant dependent upon the position of the maximum camber—given by Fig. 4.

Having established some connection between the drag due to camber and the zero-lift moment, it is interesting to note that Fig. 6 shows a similar relationship between $C_{L_{OPT}}$ and C_{M_0}. Here again it is clearly shown that the 230 series of aerofoils differ from the other aerofoils. This is not brought out by the method just previously considered: By plotting $C_{L_{OPT}}$ against $\triangle_1 C_{D_0}$ some idea is obtained of the relative value of the different centreline forms from the point of view of drag for a given value of $C_{L_{OPT}}$. Fig. 6a clearly shows that for a given $C_{L_{OPT}}$ no centreline form is of outstanding merit. It must be remembered that the 230 series have a smaller C_{M_0} for a given $C_{L_{OPT}}$ than any of the other sections.

It must be pointed out here that, although the 230 series of aerofoils have some admirable characteristics at low angles of attack, they invariably have very sudden stalls, and although $C_{L_{max}}/C_{D_{min}}$ may be large, the pilot cannot take full advantage of the maximum lift available for fear of "dropping a wing" in the event of an inadvertent stall. The question of the stalling of wings is beyond the scope of the present title, and will be discussed in a future article.

In the previous article the writer suggested the possibility of using a generalised curve to express, for practical aerofoils, the variation of drag from the minimum value in the form of:

$$\triangle_2 C_{D_0} = \int \left(\frac{C_L - C_{L_{OPT}}}{C_{L_M} - C_{L_{OPT}}} \right) \quad .. \quad .. \quad .. \quad (6)$$

The N.A.C.A. Report showed that when their tests were completed the variation in drag could not be represented by a single curve. Probably due to the higher Reynolds Number, and also to the fact that many impractical sections have been discarded, they now feel that for practical purposes the variation expressed by 6 can be adopted using a single curve. The revised values for $\triangle_2 C_{D_0}$ are given in Fig. 7, which is actually a copy of Fig. 45 of N.A.C.A. Report No. 586, with the two graphs from the previous article added for comparison.

A set of empirical corrections (Ref. 4) to the theory of thin aerofoils (Ref. 5) has been published by the present writer. Since the scale effect on the zero-lift conditions is negligible, these can still be applied with confidence.

LIST OF REFERENCES.

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2. E. N. JACOBS, K. E. WARD and R. M. PINKERTON: The Characteristics of 78 related aerofoil sections from tests in the Variable Density Tunnel. N.A.C.A. Report, 460.
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4. W. R. ANDREWS: The design of aerofoils and the prediction of characteristics. The *Aircraft Engineer*, Oct., Nov., and Dec., 1933, Jan., 1934.
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IMPROVED LAMINATED WOOD in TORSION

By EDGAR REISSNER, B Sc., D.I.C. G.R.Ae.S.I

IN recent years improved laminated wood, which is of high strength, rigidity and moisture proofness, has found considerable use in aircraft and airscrew construction. It consists of thin wood veneers glued together under high pressure and temperature. In order to make the best use of this material with regard to safety and lightness in construction, it is necessary to take into account the different behaviour of the material in the different directions (the aeolotropy) and to determine the elastic constants of this aeolotropic material and the ultimate stresses. These figures must then be applied in the stress calculations for the structural members built up from laminated wood.

As will be formulated later, the properties of laminated wood referred to the three planes of symmetry are represented by nine elastic constants, viz., 3 moduli of elasticity E_x, E_y, E_z, 3 Poisson ratios ν_x, ν_y, ν_z and 3 moduli of rigidity, G_x, G_y, G_z. The constants of these constants constitutes two independent problems. The first is solved by tension and compression experiments, the second by pure shear.

This article will occupy itself only with the question regarding the moduli of rigidity and the ultimate shear stresses and, in order to have a case of pure shear, with the application of torsion experiments on the determination of said quantities. For the sake of completeness, and as an introduction, a short and slightly simplified derivation of the torsion formula is given.

The justifiable assumption is made that the material dealt with here has three planes of symmetry (which are the three co-ordinate planes).

Reference throughout is made to:

Navier, St. Venant.—Résistance des Corps solides 1864 Paris.

Love.—Theory of elasticity, early edition about 1870.

Symbols used:—

$p_{zz} = p_z$ = stress in z direction perpendicular to x axis
$p_{xx} = p_x$ = stress in x direction perpendicular to z axis
$p_{yz} = p_y$ = stress in z direction perpendicular to y axis
$p_{zy} = p_y$ = stress in y direction perpendicular to z axis
$G_{xz} = G_z$ = modulus of rigidity in xz plane
$G_{yz} = G_y$ = modulus of rigidity in yz plane
$\gamma_{xz} = \gamma_z$ = decrease of original rectangle in xz plane
$\gamma_{yz} = \gamma_y$ = decrease of original rectangle in yz plane
u = displacement of any point in x direction
v = displacement of any point in y direction
w = displacement of any point in z direction
ω = angle of twist per unit length of rod
θ = angle of twist = ω_z
I_p = polar moment of inertia of cross-section

The condition of equilibrium (see Fig. 1) is

$$\frac{\partial}{\partial_x} p_x + \frac{\partial}{\partial_y} p_y = 0 \quad .. \quad .. \quad .. \quad .. \quad (1)$$

and the stress strain relations

$$\left.\begin{aligned} p_x &= G_z \gamma_z \\ p_y &= G_y \gamma_y \end{aligned}\right\} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (2)$$

The influence of the aeolotropy is expressed by $G_z \mp G_y$. γ is the decrease of original rectangle of an elemental prism (see Fig. 2).

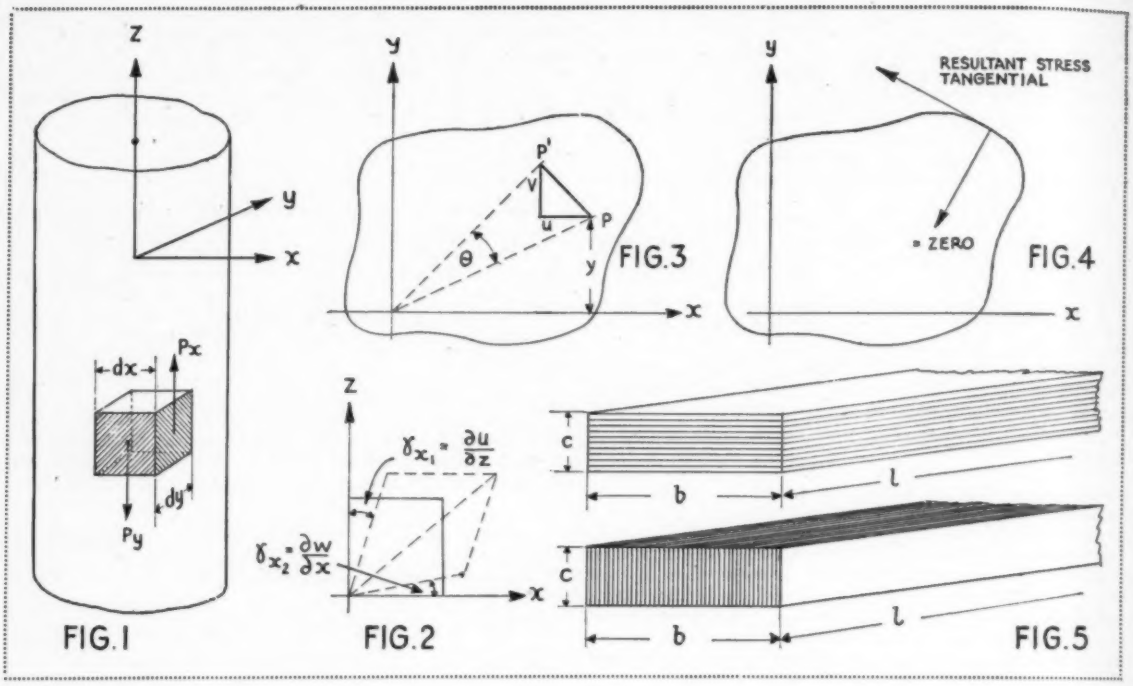
$$\left.\begin{aligned} \gamma_{x1} + \gamma_{x2} = \gamma_x &= \frac{\partial w}{\partial_x} + \frac{\partial u}{\partial_z} \\ \gamma_y &= \frac{\partial w}{\partial_y} + \frac{\partial v}{\partial_z} \end{aligned}\right\} \quad .. \quad .. \quad .. \quad (3)$$

It is assumed, and later justified by the solution (as in the theory of isotropic bodies), that every cross-section, or better its projection in an xy plane turns as a whole through some angle θ.

The displacement PP^1 of the point P can be written (see Fig. 3).

$$\begin{aligned} u &= -\theta_y \quad , \quad v = +\theta_x \\ &= -\omega_{zy} \qquad = \omega_{zx} \end{aligned} \quad .. \quad .. \quad .. \quad (4)$$

Substituting equations (2), (3), (4) in equation (1)—



$$G_x\frac{\partial^2 w}{\partial x^2} + G_y\frac{\partial^2 w}{\partial y^2} = 0 \quad .. \quad .. \quad .. \quad .. \quad (5)$$

Also, from the equilibrium conditions of the axial stresses at the elemental boundary prisms, the boundary condition (that the resultant cross-sectional stresses in the xy plane are tangential, (see Fig. 4) is

$$G_x\left(\frac{\partial w}{\partial x} - y\omega\right)dy - G_y\left(\frac{\partial w}{\partial y} + x\omega\right)dx = 0 \quad .. \quad (6)$$

In order to arrive at equations similar to those of the torsion theory for isotropic bodies let

$$x = x_1\frac{\sqrt{G_x}}{\sqrt{G}}\ ;\ y = y_1\frac{\sqrt{G_y}}{\sqrt{G}}\ ;\ G = \sqrt{G_x}\sqrt{G_y} \quad .. \quad (7)$$

which in effect means a change of co-ordinates such that the aeolotropic, now transformed, cross-sections behave like isotropic cross-sections.

Substituting (7) in (5) and (6), equations (5a) and (6a) are obtained, exhibiting clearly the aimed at simplification.

$$\nabla_{x_1 y_1}{}^2 w = \frac{\partial^2 w}{\partial x_1{}^2} + \frac{\partial^2 w}{\partial y_1{}^2} = 0 \quad .. \quad .. \quad .. \quad (5a)$$

$$\left(\frac{\partial w}{\partial x_1} - y_1\omega\right)dy_1 - \left(\frac{\partial w}{\partial y_1} + x_1\omega\right)dx_1 = 0 \quad .. \quad (6a)$$

The expression of the torsional moment, i.e., the integral of the moment of the cross-sectional stresses is

$$M = \int_0^r\int\left(p_x y - p_y x\right)dxdy, \text{ substituting (2) and (3)}$$

$$= \int_0^r\int\left[G_x y\left(\frac{\partial w}{\partial x} - \omega y\right) - G_y x\left(\frac{\partial w}{\partial y} + \omega x\right)\right]dxdy \quad (8)$$

Substituting x_1y_1G for xyG_xG_y from (7)

$$M = G\int_0^r\int\left[y_1\left(\frac{\partial w}{\partial x_1} - \omega y_1\right) - x_1\left(\frac{\partial w}{\partial y_1} + \omega x_1\right)\right]d_{x_1}d_{y_1}$$

$$= G\int_0^r\int\left(y_1\frac{\partial w}{\partial x_1} - x_1\frac{\partial w}{\partial y_1}\right)dx_1dy_1 - G\omega I_{y_1} \quad .. \quad (8a)$$

Thus we see that the "Torsion Formulæ" for aeolotropic material (5a), (6a), (8a) show, by their similarity to those for isotropic material, that an aeolotropic bar of cross-sectional dimensions b, c, behaves exactly like an isotropic bar of dimensions $b_1 = b\frac{\sqrt{G}}{\sqrt{G_x}}$; $c_1 = c\frac{\sqrt{G}}{\sqrt{G_y}}$ and modulus of rigidity $G = \sqrt{G_x}\sqrt{G_y}$. This means that the aeolotropic bar has, for given torsional couple M, the same angle of twist ωl and the axial displacement w. The stresses, however, are (like the co-ordinates)

$$p_{x_1} = p_x\frac{\sqrt{G}}{\sqrt{G_x}}\ ;\ p_{y_1} = p_y\frac{\sqrt{G}}{\sqrt{G_y}}$$

This applies to any shape of cross-section and, therefore, the available formulæ for isotropic materials can be used, after making the above transformations.

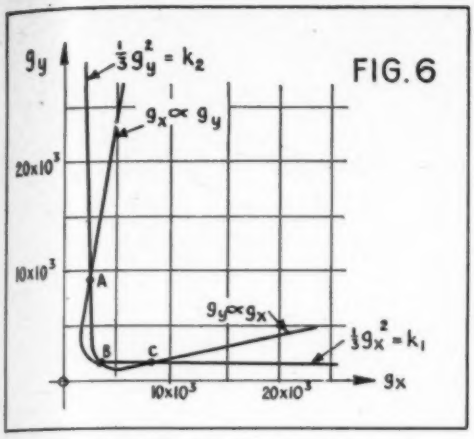
An experimental determination of G_x and G_y has been carried out on "Jablo" improved laminated wood. The specimens used in the experiment were all of length $l = 9$in. and rectangular cross-section $b = .8$in., $c = .27$in. approximately. The torsion-test apparatus was of ordinary type, giving sufficiently accurate readings of angle of twist θ and torsional couple M. The tests were carried out several times and mean values taken. It is essential to have for each test two specimens, one with lamination parallel to b and one with the lamination perpendicular to b (see Fig. 5). For both, the couple M is plotted against angle of twist θ and the straight line parts of the curves used in the calculation of G_x and G_y.

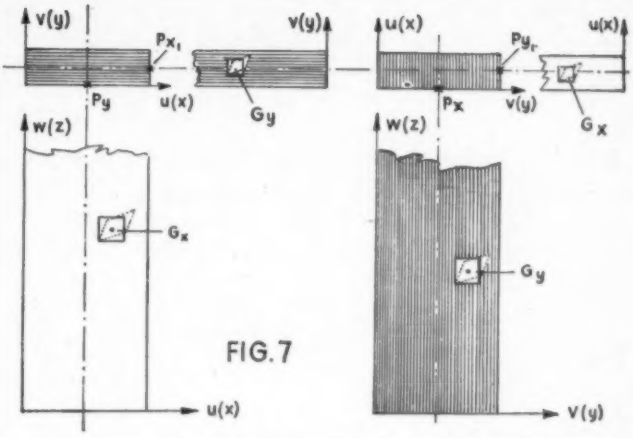
The solution of equations (5a) and (6a) has been accomplished very thoroughly by St. Venant with a complete tabulation of numerical results from which he has derived the following sufficiently exact approximative formulæ for $\left(\frac{c}{b} << 1\right)$:

$$\left(\frac{M'l}{\theta' bc^3}\right)_{\parallel b} = G_x\left(\frac{1}{3} - .21\,\frac{c}{b}\sqrt{\frac{G_x}{G_y}}\right) \quad .. \quad .. \quad (9')$$

$$\left(\frac{M''l}{\theta'' bc^3}\right)_{\perp b} = G_y\left(\frac{1}{3} - .21\frac{c}{b}\sqrt{\frac{G_y}{G_x}}\right) \quad .. \quad .. \quad (9'')$$

The solution of these equations is simplified by putting $\frac{M'l}{\theta' bc^3} = k'$, $\frac{M''l}{\theta'' bc^3} = k''$, $\sqrt{G_x} = g_x$, $\sqrt{G_y} = g_y$;





Thus equations (9′) and 9″) become

$$g_y = .21\,\frac{c}{b}\,\frac{g_x^3}{\frac{1}{3}g_x^2 - k'} \qquad .. \quad .. \quad .. \quad (10')$$

$$g_y = .21\,\frac{c}{b}\,\frac{g_y^3}{\frac{1}{3}g_y^2 - k''} \qquad .. \quad .. \quad .. \quad (10''$$

$g_x g_y$ are found graphically by determining the point or the points of intersections of (10′) and (10″), (see Fig. 6).

The shape of these curves is easily recognised, $\frac{1}{3}g^2 = k$ gives the equation to an asymptote, and $g_y \propto g_x$ for $\frac{1}{3}g^2 >> k$ gives the limiting value of the other branch of the curve as a straight line.

The theoretical distinction between the three points of intersection, A B C and the choice of the required point giving G_x and G_y is still a problem to me. However, by applying "common sense," one can determine the required point as follows: Since it was, say, A times as difficult to twist the bar through θ with the lamination $\parallel$ to b than with the lamination $\perp$ to b.

$$g_x \simeq a g_y \text{ and } \therefore\ G_x \simeq a^2 G_y$$

To ascertain the breaking shear stresses of the material, the test specimens were twisted until rupture occurred. They are given by the evaluated formulæ:

$$p_{x1} = \frac{M}{bc^2}\,\frac{3}{5}\left(5+3\frac{c}{b}\sqrt{\frac{G_x}{G_y}}\right)$$

$$p_{y1} = \frac{M}{b^2c}\,\frac{3}{5}\left(5+3\frac{b}{c}\sqrt{\frac{G_y}{G_x}}\right)$$

Rupture occurs in theory and practice at the centre line of one of the faces of the rectangular prism and for sufficiently elongated rectangular cross-sections always on the longer side.

The general stress-strain relation of material of three planes of symmetry as in the case of laminated wood are given by

$$e_{xx} = \frac{1}{E_x}\,(p_{xx} - v_{xy}\,p_{yy} - v_{xz}\,p_{zz})$$

$$e_{yy} = \frac{1}{E_y}\,(p_{yy} - v_{yz}\,p_{zz} - v_{yx}\,p_{xx})$$

Summary of Test Results on "Jablo" Improved Laminated Wood.

		.8	1.2	
Specific Gravity				
Mod. of Rigidity	Gx	1.96×10^5	3.12×10^5	Lb./Sq. inch.
	Gy	1.0×10^5	1.58×10^5	
Break Shear Stress	Px	2210	5360	
	Py	3100	7730	
Accompanying Stress	Px_1	1930	4560	
	Py_1	1310	3150	

$$e_{zz} = \frac{1}{E_z}\,(p_{zz} - v_{zx}\,p_{xx} - v_{zy}\,p_{yy})$$

$$e_{yz} = \frac{1}{G_x}\,p_{yz}$$

$$e_{xz} = \frac{1}{G_y}\,p_{xz}$$

$$e_{xy} = \frac{1}{G_z}\,p_{xy}$$

with three different moduli of elasticity $E_xE_yE_z$
with three different moduli of rigidity $G_xG_yG_z$
with three different Poisson's ratios $v_{xz}v_{yz}v_{zx}$

For pure bending, the stresses are in the same way related to the curvature $\frac{1}{R}$ and the moment of inertia I as for isotropic material

$$M = \frac{E_z I}{R}\ ;\ I = \iint x^2 dF$$

$$p = p_{zz} = -\frac{E_z x}{R} = -\frac{M}{I}x$$

$$u = \frac{1}{2}\,\frac{z^2 + v_{yz}x^2 - v_{zx}y^2}{R}\ ;\ v = v_{zx}\,\frac{xy}{R}\ ;\ w = -\frac{x_z}{R}$$

The approximate determination of the shear stresses is the same as for isotropic material and St. Venant has shown that also the exact theory of this problem may be transformed from the isotropic to this kind of aeolotropy.

AERONAUTICAL PATENT SPECIFICATIONS

(The numbers in brackets are those under which the Specifications will be printed and abridged, etc.):

(Published January 20, 1938.)

17812. WILSON, W. K., THOMAS, F. M., and DE HAVILLAND AIRCRAFT CO., LTD.: Colouring of metal surfaces (477,286).
19666. AUTOMOTIVE PRODUCTS CO., LTD., and GATES, G. R. G.: Servo-brake mechanism (477,173).
22458. AUTOMOTIVE PRODUCTS CO., LTD., BROCK, D. T., and GATES, G. R. G.: Servo-brake mechanism (477,179).
2103. JUNKERS FLUGZEUG-UND-MOTORENWERKE AKT.-GES.: Locking the control surfaces of a parked flying machine (477,194).
2961. CIBIE, P.: Projectors for automobiles, aeroplanes and the like (477,072).
4286. POLLOPAS PATENTS, LTD.: Aeroplanes (477,238).
10802. FAIREY AVIATION CO., LTD., BRAY, F. C., and BODDY, C. S.: Cover for hand holes, inspection or servicing openings, and the like (477,200).

(Published January 27, 1938).

14562. BILLOQUE, E. J. H.: Stabilising devices for aeroplanes (477,305).
17711. ABBOTH HELICOPTERS, LTD.: Wing arrangement for rotary-wing aircraft (477,349)
17838. MARCONI'S WIRELESS TELEGRAPH CO., LTD., DAVIS, N. E., GREEN, E., and HALL, A. W.: Thermionic valve apparatus for use on very short waves (477,362).
17973. HAMILTON MOTORS (LONDON) LTD., and THEED, W. D. L.: Control apparatus for aircraft with autorotative wing systems (477,369).
18158. NORMAN, H. N. ST.-V., and VULLIAMY, A. T.: Wind-direction indicators for aerodromes (477,527).
18353. SUPERMARINE AVIATION WORKS (VICKERS), LTD., and MITCHELL, R. J.: Construction of wings and other aircraft bodies or parts (477,541).
9641. AKTIEBOLAGET ATLAS DIESEL: Scavenging pumps of two-stroke internal combustion engines (477,505).
9677. MERCIER, P. E.: Device for limiting the aerodynamic efforts on aircraft (477,506).
12851. CIBIE, P.: Projectors for automobiles, bicycles, aeroplanes and the like (477,575).
22178. HANSEN, L.: Screw propellers (477,514).

AERODYNAMIC SHEAR FORCE and BENDING MOMENT in WINGS

Simple Formulæ Which Eliminate the Necessity for Graphical Integration of Span-loading Curves

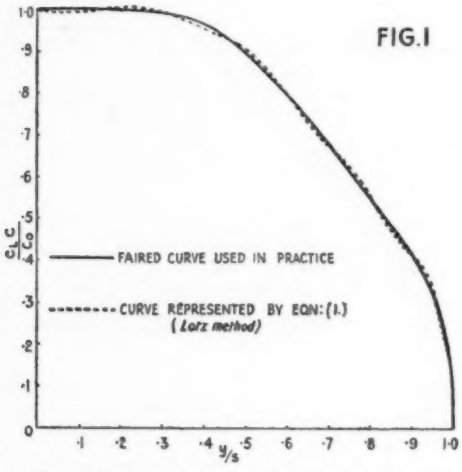
By C. F. TOMS*

Introduction

IN order to stress an aeroplane wing, two of the quantities required to be known are the shear force and bending moment at any point, due to the aerodynamic loads on the wing.

The current method of estimating these quantities is to integrate, graphically, the span-loading curve (a plot of $\left(\frac{C_L C}{C_o}\right)$ against y/s, where C_L and C are the local lift coefficient and chord, y and s are defined hereunder) from the tip of the wing, into the point in question, multiplying the result by appropriate factors to allow for scale, speed, etc., and then to repeat the process, with the curve obtained by the above operation. The first operation gives the shear force diagram, the second the bending moment diagram.

This process is rather tedious, however, and liable to cumulative error. Therefore, an analytical method has been sought.



This paper develops two simple groups of coefficients, called respectively,

Shear force coefficient (S.F.)c, and

Bending moment coefficients (B.M.)c.

The span-loading curve for an aerofoil is given by the equation :—

$$\frac{C_L C}{C_o} = A_1 \sin\theta + A_3 \sin 3\theta + A_5 \sin 5\theta + A_7 \sin 7\theta \qquad \text{——————(1)}$$

where :—

C = chord at point considered

C_o = chord at axis of symmetry of aerofoil.

The substitution made is :—

$y = -s\cos\theta$

where :—

y = dist. of point considered from axis of symmetry

s = semi-span of aerofoil, so that θ varies from $\pi/2$ to π, across the starboard half of the aerofoil.

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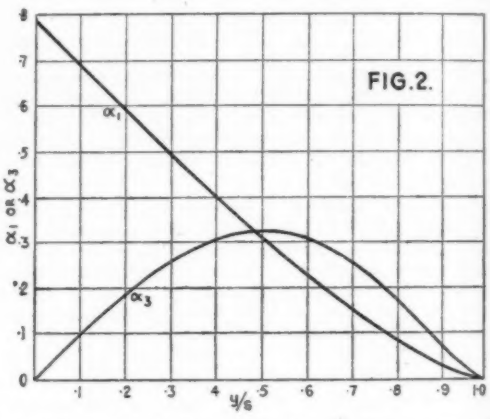
It must be noted here that it may be unsatisfactory to use these formulæ with the coefficients A_1, etc., in (1) (more especially in the case of twisted, e.g. flapped wings), if the said coefficients have been calculated to conform with the characteristics of the wing at a few points only.

This is because the curve obtained by smoothly joining the values given by (1) at the particular points at which the coefficients A_1, etc., apply, is not identical with the locus of all points along the semi-span represented by (1). This is graphically explained in Fig. 1.



As the number of points along the semi-span with which the coefficients A_1, etc., are made to conform increases, the magnitude of this variation decreases. In the course of a calculation by the Lotz method, ten such points are satisfied, and the variation is quite small.

The points are :—

y/s	0	.156	.309	.454	.588	.707	.809	.891	.951	.988
$\theta°$	90	99	108	117	126	135	144	153	162	171

and these have been retained as the points at which to make the arithmetical substitutions.

(*a*) *Aerodynamic Shear Force*

The aerodynamic shear force at a point distant as from the axis of symmetry is given by :—

$$\text{S.F.} = s\int_a^1 \left(\frac{C_L C}{C_o}\right)\left(C_o \cdot \frac{\rho}{2} \cdot V^2\right) dy.$$

$$= s.C_o.\frac{\rho}{2}.V^2 \int_a^1 \left(\frac{C_L C}{C_o}\right) dy. \qquad \text{——————(2)}$$

(1) may be written

$$\left(\frac{C_L C}{C_o}\right) = \sum_{n=1}^{n=4} A_{2n-1} \sin(2n-1)\theta. \qquad \text{——————(3)}$$

Substituting this in (2) we get, putting θ at $y/s = a$, equal to θ_o :—

$$\text{S.F.} = s.C_o.\frac{\rho}{2}.V^2 \int_{\theta_o}^{\pi} \sum_{n=1}^{n=4} A_{2n-1} \sin(2n-1)\theta.\sin\theta\, d\theta. \qquad \text{—(4)}$$

The term outside the integral has a constant numerical value for all points along the semi-span in any particular case. The evaluation of the integral gives :—

$$\frac{A_1}{2}\left(\pi - \theta_0 + \frac{\sin 2\theta_0}{2}\right) - \tfrac{1}{4}\sum_{n=2}^{n=4} A_{2n-1}\left(\frac{\sin 2(n-1)\theta_0}{(n-1)} - \frac{\sin 2n\theta_0}{n}\right)$$

Substituting $n = 2, 3, 4$, we get :—

$$\frac{A_1}{2}\left(\pi-\theta_0+\frac{\sin 2\theta_0}{2}\right) - \tfrac{1}{4}\left\{A_3\left[\sin 2\theta_0 - \frac{\sin 4\theta_0}{2}\right] + A_5\left[\frac{\sin 4\theta_0}{2} - \frac{\sin 6\theta_0}{3}\right] + A_7\left[\frac{\sin 6\theta_0}{3} - \frac{\sin 8\theta_0}{4}\right]\right\} \quad \text{—(5)}$$

Multiplying this expression by the constant term:—

$$\text{s.C}_0.\frac{P}{2}.V^2 = \text{S.C}_0.q$$

gives

$$\text{S.F.} = \text{s.C}_0.q\left[A_1\alpha_1 + A_3\alpha_3 + A_5\alpha_5 + A_7\alpha_7\right] \quad \text{——(6)}$$

where

$$\left.\begin{aligned}\alpha_1 &= \tfrac{1}{2}\left(\pi - \theta_0 + \frac{\sin 2\theta_0}{2}\right)\\ \alpha_3 &= -\tfrac{1}{4}\left(\sin 2\theta_0 - \frac{\sin 4\theta_0}{2}\right)\\ \alpha_5 &= -\tfrac{1}{4}\left(\frac{\sin 4\theta_0}{2} - \frac{\sin 6\theta_0}{3}\right)\\ \alpha_7 &= -\tfrac{1}{4}\left(\frac{\sin 6\theta_0}{3} - \frac{\sin 8\theta_0}{4}\right)\end{aligned}\right\} \quad \text{————(7)}$$

These coefficients (7) are the shear force coefficients (S.F.)c and are seen to be solely functions of θ_0, i.e., of the fraction of the semi-span at which the shear force is to be calculated, obviously.

Thus, it is unnecessary to proceed further with the loading calculation than the evaluation of the coefficients A_{2n-1}, in order to evaluate the shear ; the same will be shown to be true of the bending moment.

Since the total lift on a wing depends only on the coefficient A_1 (the other coefficients merely modifying the shape of the curve), the maximum shear, which occurs at the axis of symmetry is also solely dependent on A_1, and is therefore given by :—

$$\text{S.F.} = C_0.\text{s.}q.A_1.a_1 \quad .. \quad .. \quad .. \quad .. \quad (8)$$

The coefficients a_1, a_3, a_5, a_7, are plotted in Figures 2 and 3, and the numerical values are given in Table 1.

Elliptic Loading

In the particular case of elliptic loading (7) is true at all points along the semi-span since A_3, A_5 and A_7 are each zero.

TABLE I

y/s	α_1	α_3	α_5	α_7
0	.7853	0	0	0
.156	.6296	.1507	— .1409	.1269
.309	.4813	.2658	— .1981	.1160
.454	.3475	.3211	— .1446	— .0110
.588	.2333	.3112	— .0245	— .1084
.707	.1425	.2500	.0833	— .0833
.809	.0763	.1643	.1224	.0105
.891	.0332	.0834	.0931	.0625
.951	.00995	.0281	.0396	.0425
.988	.00105	.00378	.00605	.00798
1.000	0	0	0	0

The coefficients a_5 and a_7 are seen, from Fig. 3, to have zero value at several points along the semi-span (excluding $y/s = 0$ and 1). The exact values of y/s are found by equating a_5 and a_7 in (7) to zero.

For a_5 this occurs at $y/s = .613$, and for a_7 at $y/s = .443$ and .799.

Thus, we have :—

$$\left.\begin{aligned}&\text{S.F. at } y/s = .443 :-\\ &\quad \text{s.C}_0.q[.357\,A_1 + .319\,A_3 - .152\,A_5]\\ &\text{S.F. at } y/s = .613\\ &\quad \text{s.C}_0.q[.214\,A_1 + .302\,A_3 - .114\,A_5]\\ &\text{S.F. at } y/s = .799\\ &\quad \text{s.C}_0.q[.083\,A_1 + .108\,A_3 + .122\,A_5]\end{aligned}\right\} \quad .. \quad (9)$$

These expressions (9), combined with equation (8), give a slightly simplified method of calculating the shear at four points along the semi-span. Other values may be quickly obtained by plotting these against y/s.

(*b*) *Aerodynamic Bending Moment*

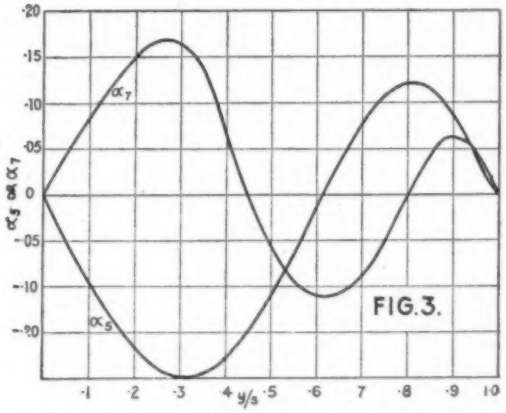
The aerodynamic bending moment at a point distant σs from the axis of symmetry is given by :—

$$\text{B.M.} = s^2\int_\sigma^1 \left(\frac{C_L C}{C_0}\right)\left(C_0.\frac{\rho}{2}.V^2\right)(y - \sigma)\,dy$$

$$= s^2.C_0.\frac{\rho}{2}.V^2\left[\int_\sigma^1 \left(\frac{C_L C}{C_0}\right) y.dy - \sigma\int_\sigma^1 \left(\frac{C_L C}{C_0}\right) dy\right] \quad (10)$$

Putting $\sigma = -\cos.\theta_0$, and substituting for (3), we get :—

$$\text{B.M.} = s^2.C_0.\frac{\rho}{2}V^2\left[-\tfrac{1}{2}\int_{\theta_0}^{\pi}\sum_{n=1}^{n=4} A_{2n-1}.\sin(2n-1)\theta.\sin 2\theta.d\theta + \cos\theta_0\int_{\theta_0}^{\pi}\sum_{n=1}^{n=4} A_{2n-1}.\sin(2n-1)\theta.\sin\theta.d\theta\right]$$
$$.. \quad .. \quad .. \quad .. \quad .. \quad (11)$$



The term outside the bracket has a constant numerical value in any particular case, as before, and the evaluation of the integrals gives :—

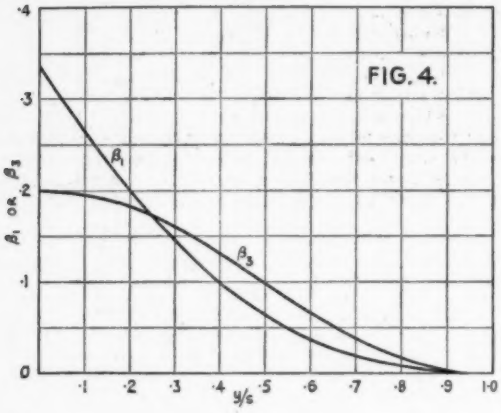
$$\tfrac{1}{4}\sum_{n=1}^{n=4} A_{2n-1}\left(\frac{\sin(2n-3)\theta_0}{(2n-3)} - \frac{\sin(2n+1)\theta_0}{(2n+1)}\right) + \frac{A_1.\cos\theta_0}{2}\left(\pi - \theta_0 + \frac{\sin 2\theta_0}{2}\right) - \frac{\cos\theta_0}{4}\sum_{n=2}^{n=4} A_{2n-1}\left(\frac{\sin 2(n-1)\theta_0}{(n-1)} - \frac{\sin 2n\theta_0}{n}\right)$$
$$.. \quad .. \quad .. \quad .. \quad .. \quad (12)$$

Substituting $n = 1, 2, 3, 4$, we get :—

$$\left.\begin{aligned}&A_1\left[\tfrac{1}{4}\left(\sin\theta_0 - \frac{\sin 3\theta_0}{3}\right) + \frac{\cos\theta_0}{2}\left(\pi - \theta_0 + \frac{\sin 2\theta_0}{2}\right)\right]\\ &+ A_3\left[\tfrac{1}{4}\left(\sin\theta_0 - \frac{\sin 5\theta_0}{5}\right) - \frac{\cos\theta_0}{4}\left(\sin 2\theta_0 - \frac{\sin 4\theta_0}{2}\right)\right]\\ &+ A_5\left[\tfrac{1}{4}\left(\frac{\sin 3\theta_0}{3} - \frac{\sin 7\theta_0}{7}\right) - \frac{\cos\theta_0}{4}\left(\frac{\sin 4\theta_0}{2} - \frac{\sin 6\theta_0}{3}\right)\right]\\ &+ A_7\left[\tfrac{1}{4}\left(\frac{\sin 5\theta_0}{5} - \frac{\sin 9\theta_0}{9}\right) - \frac{\cos\theta_0}{4}\left(\frac{\sin 6\theta_0}{3} - \frac{\sin 8\theta_0}{4}\right)\right]\end{aligned}\right\} \quad (13)$$

Multiplying the expression by the constant term

$$q.s^2.C_0$$



gives

$$\text{B.M.} = q.s^2.C_0[A_1\beta_1 + A_3\beta_3 + A_5\beta_5 + A_7\beta_7] \quad .. \quad (14)$$

where β_1, β_3, β_5, β_7 are the values of the terms in square brackets, which are again seen to be functions of θ_0 only. These are the bending moment coefficients (B.M.)c.

The coefficients $\beta_1 - \beta_7$ are plotted in Figs. 4 and 5, and the numerical values are given in Table II.

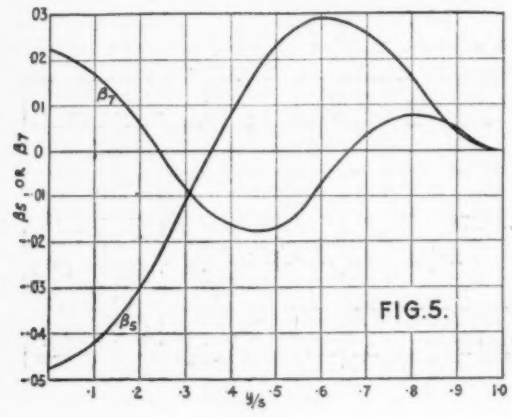


TABLE II

y/s	β_1	β_3	β_5	β_7
0	.3333	.2000	— .0476	.0222
.156	.2227	.1880	— .0360	.0112
.309	1380	.1557	— .0083	— .0096
.454	.0780	.1123	.0174	— .0177
.588	.0304	.0693	.0291	— .0088
.707	.0171	.0353	.0253	.0039
.809	.0060	.0140	.0142	.0078
.891	.0016	.0038	.0050	.0044
.951	.00036	.0006	.0008	.0010
.988	.00023	.0003	.00002	.00005
1.000	0	0	0	0

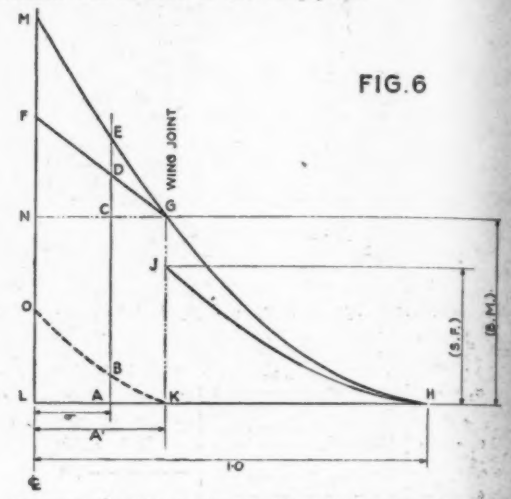
As in the case of the shear force, simplified expressions exist for the bending moment at three points, as below (very slight arithmetical approximations are made in equations (9) and (15)).

We have :—

$$\left.\begin{array}{l}\text{B.M. at } y/s = .239 :- \\ \quad s^2.C_0.q[.174\,(A_1 + A_3) - .022\,A_5] \\ \text{B.M. at } y/s = .354 :- \\ \quad s^2.C_0.q[.122A_1 + .143\,A_3 - .014\,A_5 \\ \text{B.M. at } y/s = .660 :- \\ \quad s^2.C_0.q[.025\,A_1 + .048\,A_3 + .028\,A_5]\end{array}\right\} \quad .. \quad (15)$$

At $y/s = 0$, the full expression must be used.

In the process of stressing wings which have a dihedral commencing at the wing joint, somewhere along the semi-span, it may be necessary to find the bending moment curve for the portion of the wing inside the joint, neglecting the loading on the remainder of the wing ; i.e., the bending moment will be zero at the wing joint.



Referring to Fig. 6, the total bending moment at a point σs from the axis of symmetry is given by the ordinate AE. Now, neglecting the loading *inside* the wing joint, the bending moment curve is HGDF, GDF being a straight line, where FN = (KJ) (A's), i.e., the bending moment at the axis of symmetry = the bending moment at wing joint + S.F. at wing joint × (A's)

Hence, at a point σs from the axis of symmetry, the bending moment due to the loading *inside* the wing joint is given by :—

$$AE - KG - KJ(A' - \sigma)s$$

or :

(True B.M.) — (B.M. at wing joint) — (S.F. at wing joint × $(A' - \sigma)s$)

Thus, the shape of the bending moment curve, KBO, due to the loading *inside* the wing joint only, may be easily determined from the foregoing formulæ.

The formulæ contained in this paper have been checked by graphical integration, in a case where the coefficients A_3, A_5, and A_7 were not negligible, and they gave results well within the limits of accuracy of the graphical method.

In the preparation of the paper, I am indebted to Mr. J. R. Crean, B.Sc. (Eng.), for several helpful suggestions.

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